3

Remote Operation

3.1 Introduction

Introduction (Remote Operation)	Model	
	124XXA	125XXA/ 127XXA
3.1.1 - Languages Available	√	√

The Series 12000A Microwave Synthesizers can be operated from a remote host over the General Purpose Interface Bus (GPIB) using either Standard Commands for Programmable Instruments (SCPI) or Native language commands. Operation via the RS-232 interface is possible using the Native commands for all three models.

☛ ***NOTE:*** *The unit may be operated via its RS-232 interface, using the same language(s) as are supported on its GPIB interface. Other GPIB functionality, such as that provided by the GPIB lines IFC, SRQ, etc., and by GPIB multiline messages, such as GET, DCL, etc., are not supported over the RS-232 interface. The RS-232 interface's parameters are: 9600 baud, 8 bits per character, 1 stop bit, no parity, and neither software (XON/XOFF) nor hardware (RTS/CTS) flow control. Commands must be terminated with a carriage return. Any legal command following an unrecognized command is ignored until a carriage return. The sending of commands prior to the unit's completion of its powerup initialization is not recommended. The use of both the GPIB and the RS-232 interface at the same time is not allowed.*

3.1.1 Languages Available

All synthesizer functions are designed to be controlled over the General Purpose Interface Bus (GPIB). At present, SCPI and IEEE 488 Native languages are implemented. These languages are introduced briefly below, and discussed in more detail under separate headings.

- Standard Commands for Programmable Instruments (SCPI) is a language specified by the SCPI Consortium. It is designed to standardize commands and data to and from instruments regardless of the manufacturer. SCPI promotes consistency from the remote programming standpoint between instruments, which are of the same class or have the same functional capability. For a given function such as frequency or power, SCPI specifies the command set that is available for that function
- The Native syntax is a set of IEEE 488 commands developed for remote control of Giga-tronics instruments

3.2 SCPI Command Codes

SCPI Command Codes	Model	
	124XXA	125XXA/ 127XXA
3.2.1 - SCPI Command Format	√	√
3.2.2 - SCPI Mandated Commands	√	√
3.2.3 - SCPI SOURCe Commands	√ (See Section for N/A Commands)	√
3.2.4 - SCPI Status Commands	√	√
3.2.5 - Sample SCPI Commands	√	√

The SCPI syntax implemented in the Series 12000A includes the IEEE 488.2 Common commands, status reporting, error reporting, and table-specified defaults at power-up or *RST.

3.2.1 SCPI Command Format

Details of typography (such as indentation, case, and punctuation) are very significant in SCPI and must be attended to with great care. The typographic conventions employed in the SCPI command tables which follow are summarized here.

Colons indicate changes of level in the SCPI tree structure. If a command is represented in the format ALPHA:BETA:GAMMA, then BETA is one level down from ALPHA, and GAMMA is two levels down from ALPHA. If ALPHA is printed at the left margin, ALPHA is at the root level.

Commands can be entered in upper- or lowercase. However, only required letters are in upper case in the command structure. If entering more than the required letters, enter the entire command (e.g., if the command is INITiate, use either INIT or INITIATE, but INITI is invalid).

If a command is shown in square brackets, it is an implied command and can be omitted (The brackets are not part of the command and should be omitted even if the command itself is entered). An implied command is the default command among the commands available at its level. For example, in the case of the command INITiate:[IMMediate], the immediate mode is the default mode, so entering INIT has the same effect as entering INIT:IMM.

Because querying any value can be set, most commands also exist in a query form (Signified by a question mark at the end of the command). Some commands are events that cause something to happen at a particular time but do not create a setting or value to be checked afterwards. Consequently, they have no query form.

Some commands require a parameter. The parameter types are listed below for all three models:

Boolean	A Boolean (true or false) condition. Enter: ON or 1 for TRUE OFF or 0 for FALSE
NUM_VAL	A numeric value or a qualitative term which represents a numeric value. Enter: Sign (optional) value digits decimal point (optional) E xx (optional) units suffix (optional) Or Enter: MIN or MAX UP or DOWN (these only change the synthesizer's output frequency or output power level)
NUM	A number, which typically represents register bit settings in the form of a decimal integer

There are also discrete parameters. These are options to be chosen from a limited selection. For example, the TRIGger:SLOPe command has three possible discrete parameters to chose from (POSitive, NEGative, and NONe).

The beginning of a parameter must be preceded by a space. The default units suffixes are DB for power and HZ for frequency (optional parameters for frequency are KZ, MZ and GZ).

3.2.2 SCPI Mandated Commands

The following are SCPI mandated commands. The command syntax is followed by a description of the command. Many of these commands refer to the Status System, which is discussed in detail in Section 3.2.4. Commands beginning with an asterisk are IEEE 488.2 Common Commands.

SCPI Mandated Commands	Model	
	124XXA	125XXA/ 127XXA
*CLS	√	√
*IDN?	√	√
*OPC	√	√
*OPC?	√	√
*RST	√	√
*TST?	√	√
*OPAS	√	√
*OS	√	√

*CLS

Syntax:	*CLS
Response:	N/A
Description:	Clear Status. This command clears the event registers in all status groups. It also clears the Event Status Register and the Error/Event Queue.

*IDN?

Syntax:	*IDN?
Description:	Identification query. The response takes the form of four ASCII fields separated by commas. The fields are: (1) Manufacturer, (2) Model, (3) Serial Number, and (4) Firmware Level or Equivalent. Fields 1 and 2 are required; fields 3 and 4 are filled by zeros if the data is not available.

*OPC

Syntax:	*OPC
Description:	Operation Complete. This command causes the Operation Complete bit (that is, Bit 0 of the Standard Event Status Register) to be set to 1 when all pending selected device operations have been finished.

*OPC?

Syntax:	*OPC?
Description:	This query form places an ASCII character 1 into the device's output queue when all pending selected device operations have been finished. Unlike the *OPC command, the *OPC? query does not affect the OPC Event bit in the Standard Event Status Register (ESR).

*RST

Syntax:	*RST
Description:	The Reset command sets the device-specific functions to a known state (the power-on state) that is independent of the past-use history of the device. The command does not reset any part of the status reporting system.

*TST?

Syntax:	*TST?
Description:	No external equipment is required to run the self-test. Disconnect any equipment that is connected to the RF Output before running the self-test as the synthesizer might generate high output power during the test. When the self-test is complete, the synthesizer is set to the original state. Self-test performs a list of various frequency and power levels to assure the instrument responds normally. A message, "Self-test passed" returns if no errors are found during the test or else returns the synthesizer to the frequency and power level that caused the test failure. The Self-Test query command causes the synthesizer to perform a self-test routine. See the notes below concerning Self-Test. The Self-Test routine will preserve (save and later restore) these states: **RF On/Off State** **CW Frequency Value** **Power Level Coarse Value** **Power Level Fine Value**

OPAS

Syntax:	OPAS
Response:	Returns a string containing the status of Loc, Level and Calibration
Description:	This command oupts the Lock, Level and Calibration status. A "1" represents Locked, leveled, or calibrated respectively; a "0" represents unlocked, unleveled, or un-calibrated respectively.

OS

Syntax:	OS
Response:	Returns a binary string containing the status bits of Lock, Level and Calibration.
Description:	This command ouputs a 16-bit binary format string as described in the following table.

Bits	Condition
15	Not used - always 0
14	Not used - always 0
13	Not used - always 0
12	Not used - always 0
11	Not used - always 0
10	Not used - always 0
9	Not used - always 0
8	Not used - always 0
7	0 = instrument is not leveled 1 = instrument is leveled
6	Not used - always 0
5	Not used - always 0
4	Not used - always 0
3	Not used - always 0
2	Not used - always 0
1	0 = instrument is not locked 1 = instrument is locked
0	0 = instrument is not calibrated 1 = instrument is calibrated

Example:	Output string, “0000000010000011”, means instrument is calibrated, locked and leveled.

3.2.3 SCPI SOURCe Commands

SCPI Source commands are divided into the sections listed below. In some cases the Source code may contain additional sets of functions. All Source subsystem commands begin with [SOURce], but as [SOURce] is the default command at the root level it need not be entered. The following SOURce subsystems are used in the 12000A:

SCPI SOURCe Commands	Model	
	124XXA	125XXA/ 127XXA
AM	N/A	√
FM	N/A	√
FREQuency	√	√
LIST	√	√
MARKer	√	√
POWer	√	√
PULSe	N/A	√
SWEep	√	√
SYSTem	√	√
TRIGger	√	√

3.2.3.1 AM Subsystem Commands (Series 12500A/12700A Only)

The Amplitude Modulation subsystem sets the modulation controls and the parameters associated with the modulating signal(s).

- **AM:DEPTh**
- **AM:INTernal:FUNCtion:SHAPe**
- **AM:SCALing**
- **AM:SCAN**
- **AM:STATe**
- **AM:SOURc:EXTernal**
- **AM:TYPE**

AM:DEPTh

Syntax:	AM: <*Num_Val*>	
Example:	AM 40	! Set the AM depth to 40%
Description:	Sets the depth of Amplitude Modulation to *d* percent in internal mode.	

AM:INTernal:FUNCtion:SHAPe

Syntax:	AM:INTernal:FUNCtion:SHAPe OFF | SINE | SQUare | TRIangle | PRaMP | NRaMP	
Example:	AM:INTernal:FUNCtion:SHAPe OFF	! Set the internal AM waveform to OFF
Description:	Allows user to assign an AM waveform from one of the following choices: off, sine, square, triangle, positive ramp and negative ramp.	

AM:SCALing

Syntax:	AM: Scaling *n*	
Example:	AM: Scaling 10	! Set the AM scaling rate to 10%
Description:	Sets the scaling of Amplitude Modulation to n %/V in external mode.	

AM:SCAN

Syntax:	AM: SCAN *n*	
Example:	AM: SCAN 2	! Activates internal Scan Amplitude Modulation
Description:	Activate and select the source of the Scan AM according to the following values for *n*:	
	n = 0	Deactivate (turn off) Scan Amplitude Modulation.
	n = 1	Activate external Scan Amplitude Modulation **(Only with Option 29)**.
	n = 2	Activate internal Scan Amplitude Modulation **(Only with Options 24 and 29)** and select sine wave.
	n = 3	Activate internal Scan Amplitude Modulation **(Only with Options 24 and 29)** and select square wave.
	n = 4	Activate internal Scan Amplitude Modulation **(Only with Options 24 and 29)** and select triangle wave.
	n = 5	Activate internal scan **(Only with Options 24 and 29)** and select positive ramp.
	n = 6	Activate internal scan **(Only with Options 24 and 29)** and select negative ramp.
	n = 7	Activate internal scan **(Only with Options 24 and 29)** and select noise.
	n = 8	Activate internal scan **(Only with Options 24 and 29)** and select zero output.

AM:STATe

Syntax:	AM <*Boolean*>	
Example:	AM ON (*or* OFF)	! Turn the AM output ON (*or* OFF)
Description:	The command activates or deactivates the AM mode.	

AM:SOURce:EXTernal

Syntax:	AM:SOURce:EXTernal <*Boolean*>	
Example 1:	AM:SOURce:EXTernal ON	! Select a single external modulation source
Example 2:	AM:SOURce:EXTernal 1 ON, EXTernal 2 ON	! Select two external modulation sources
Description:	Selects INTernal and/or EXTernal sources for the modulating signal. Single or multiple sources can be selected. Any source not included in the current selection will be deselected and turned off. When multiple sources are selected, the respective sources must be suffixed with a number. If a number is not included, it is assumed to be 1.	

AM:TYPE

Syntax:	AM:TYPE <*Boolean*>	
Example:	AM:TYPE LOGarithmic	! Select LOGarithmic AM shaping
Description:	This command controls the AM shaping. The default is LINear. LINear = The output voltage is directly proportional to V_{mod}. LOGarithmic = The output voltage is proportional to log (V_{mod}). EXPonential = The output voltage is proportional to 10 (V_{mod}).	

3.2.3.2 FM Subsystem Commands (Series 12500A/12700A Only)

The Frequency Modulation command subsystem sets the modulation controls and the parameters associated with the FM signal(s). The FM commands used in the 12000A are:

- **FM[:DEViation]**
- **FM:INTernal:FUNCtion:SHAPe**
- **FM:SENSitivity**
- **FM:SOURce**
- **FM:STATe**
- **FM:TYPE**
- **FM:TYPE?**

FM[:DEViation]

Syntax:	FM <*Num_Val*>	
Example:	FM 100	! Set the FM deviation to 100 Hz
Description:	This command sets the modulation deviation of an FM signal. The unit for deviation is Hertz (Hz).	

FM:INTernal:FUNCtion:SHAPe

Syntax:	FM:INTernal:FUNCtion:SHAPe OFF | SINE | SQUare | TRIangle | PRaMP | NRaMP	
Examples:	FM:INTernal:FUNCtion:SHAPe SINE FM:INTernal:FUNCtion:SHAPe OFF	! Set the FM waveform to SINE waveform ! Set the FM waveform to OFF
Description:	Allows user to assign an FM waveform from one of the following choices: off, sine, square, triangle, positive ramp and negative ramp.	

FM:SENSitivity

Syntax:	FM:SENSitivity <*Num_Val*>	
Example:	FM:SENSe 10	! Set the FM sensitivity to 10 Hz/volt
Description:	This command controls the modulation deviation by setting a sensitivity Modulation to the modulation voltage level. The unit for SENSitivity is Hertz/volt (Hz/V).	

FM:SOURce

Syntax:	FM:SOURce INTernal | EXTernal (EXTernal | INTernal)	
Example:	FM:SOURCe EXTernal	! Select the FM signal source
Description:	Selects INTernal and/or EXTernal sources for the modulating signal. Single or multiple sources can be selected. Any source not included in the current selection will be deselected and turned off. When multiple sources are selected, the respective sources must be suffixed with a number. If a number is not included, it is assumed to be 1.	

FM:STATe

Syntax:	FM:STATe <*Boolean*>	
Example:	FM:STATe ON (*or* OFF)	! Turn the FM output ON (*or* OFF)
Description:	This command activates or deactivates the FM mode.	

FM:TYPE

Syntax:	FM:TYPE	
Example:	FM:TYPE	! Switch to another model
Description:	It sets the mode for Frequency Modulation. The available modes are Narrow and Wide mode. Every time this command is executed, it switches to another mode.	

FM:TYPE?

Syntax:	FM:TYPE?	
Example:	FM:TYPE?	! Returns the current FM mode
Description:	This command activates or deactivates the FM mode.	

3.2.3.3 FREQuency Subsystem Commands

The Frequency subsystem commands control the frequency sweep characteristics of the 12000A. This subsystem includes the following commands:

- **FREQuency[:CW | :FIXed]**
- **FREQuency[:CW | :FIXed]?**
- **FREQuency[:CW | :FIXed]:RES**
- **FREQuency[:CW | :FIXed]:STEP**
- **FREQuency[:CW | :FIXed]:STEP[:INCRement]**
- **FREQuency[:CW | :FIXed]:STEP[:INCRement]?**
- **FREQuency:CENTer**
- **FREQuency:CENTer?**
- **FREQuency:MODE**
- **FREQuency:SPAN**
- **FREQuency:SPAN?**
- **FREQuency:STARt**
- **FREQuency:STARt?**
- **FREQuency:STOP**
- **FREQuency:STOP?**

FREQuency[:CW | :FIXed]

Syntax:	FREQuency <*Num_Val*>	
Example:	FREQuency 1000	! Set the unit to CW frequency of 1000 HZ
Description:	The CW or FIXed mode selects a frequency of a non-swept signal. Optional units in place of HZ are MIN, MAX, UP, or DOWN. The commands FREQuency[:CW] and FREQuency[:FIXed] are synonymous; either command specifies a fixed frequency for the synthesizer.	

FREQuency[:CW | :FIXed]?

Syntax:	FREQuency?
Description:	This command queries and reports the current CW/Fixed frequency.

FREQuency[:CW | :FIXed]:RES

Syntax:	FREQuency:RES <*Num_Val*> [HZ | KZ | MZ | GZ]	
Example:	FREQuency:RES 100	! Set the CW frequency resolution to 100 Hz
Description:	This command sets the absolute increment/decrement at which the frequency of the output signal can be changed. The default value is HZ.	

FREQuency[:CW | :FIXed]:STEP

Syntax:	FREQuency:STEP <*Num_Val*> [HZ | KZ | MZ | GZ]	
Example:	FREQuency:STEP 100 HZ	! Set the sweep frequency step to 100 Hz
Description:	This command specifies a sweep frequency step size. The commands **FREQuency[:CW]** and **FREQuency[:FIXed]** are synonymous; either command specifies a fixed frequency for the synthesizer.	

FREQuency[:CW | :FIXed]:STEP[:INCRement]

Syntax:	FREQuency:STEP[:INCRement] <*Num_Val*>	
Example:	FREQuency:STEP 100	! Set the sweep frequency step size to 100 Hz
Description:	This command specifies a step size for sweeping or for UP/DOWN incrementing. The unit value is Hertz. Optional units in place of HZ are MIN, MAX, UP, or DOWN. The commands **FREQuency[:CW]** and **FREQuency[:FIXed]** are synonymous; either command specifies a fixed frequency for the synthesizer.	

FREQuency[:CW | :FIXed]:STEP[:INCRement]?

Syntax:	FREQuency:STEP?
Description:	The is the query form to report the CW/Fixed frequency step increment size.

FREQuency:CENTer

Syntax:	FREQuency:CENTer <*Num_Val*>	
Example:	FREQuency:CENTer 100 MZ	! Set the center frequency to 100 MHz
Description:	This command sets the CENTer frequency of a sweep. The default unit is MZ; additional unit options are HZ, KZ and GZ.	

FREQuency:CENTer?

Syntax:	FREQuency:CENTer?
Description:	This is the query form to report the center frequency.

FREQuency:MODE

Syntax:	FREQuency:MODE CW|FIXed|SWEep|LIST|SENSe	
Example 1:	FREQuency:MODE CW	! Set the CW commands to control the frequency subsystem
Example 2:	FREQuency:MODE LIST	! Set the List commands to control the frequency subsystem
Description:	This command establishes which set of commands will be used to control the frequency subsystem. The settings have the following meanings:	
	CW|FIXed:	The frequency is determined by FREQuency[:CW] or [:FIXed]. CW and FIXed are interchangeable, both must be implemented if either is implemented.
	SWEep:	The source is in the swept mode and the frequency is determined by FREQuency:STARt, STOP, CENTer, SPAN, and MAN (manual).
	LIST:	The source is in the LIST sequence mode and the frequency is determined by LIST:FREQuency (Refer to the LIST subsystem commands in this section).

FREQuency:SPAN

Syntax:	FREQuency:SPAN <*Num_Val*> [HZ | KZ | MZ | GZ]	
Example:	FREQuency:SPAN 200 MZ	! Set the frequency span to 200 MHz
Description:	This command sets the sweep frequency span.	

FREQuency:SPAN?

Syntax:	FREQuency:SPAN?
Description:	This is the query form to report the SPAN of the sweep frequency.

FREQuency:STARt

Syntax:	FREQuency:STARt <*Num_Val*> [HZ | KZ | MZ | GZ]	
Example:	FREQuency:STARt 200 HZ	! Set the sweep starting frequency to 200 kHz
Description:	This command sets the STARt frequency. It also sets the lower limit of a manual sweep.	

FREQuency:STARt?

Syntax:	FREQuency:STARt?
Description:	This is the query command to report the STARt frequency.

FREQuency:STOP

Syntax:	FREQuency:STOP <*Num_Val*> [HZ | KZ | MZ | GZ]	
Example:	FREQuency:STOP 100 MZ	! Set the sweep stop frequency to 100 MHz
Description:	This command sets the STOP frequency. It also sets the upper limit of a manual sweep.	

FREQuency:STOP?

Syntax:	FREQuency:STOP?
Description:	This is the query command to report the STOP frequency.

3.2.3.4 LIST Subsystem Commands

- **LIST:ADD:POINt**
- **LIST:DELete:LIST**
- **LIST:DELete:POINt**
- **LIST:DWELl**
- **LIST:DWELl:POINt**
- **LIST:DWELl:POINt?**
- **LIST:FREQuency**
- **LIST:FREQuency:POINt**
- **LIST:FREQuency:POINt?**
- **LIST:PRECompute?**
- **LIST:POWer**
- **LIST:POWer:POINt**
- **LIST:POWer:POINt?**
- **LIST:RANGe:ADD**
- **LIST:RANGe:DWELl**
- **LIST:RANGe:POWer**
- **LIST:RANGe:STARt**
- **LIST:RANGe:STEP**
- **LIST:RANGE:STOP**
- **LIST:REPeat**
- **LIST:RUN**
- **LIST:TRIGger:SOURce**

LIST:ADD:POINt

Syntax:	LIST:ADD:POINt *n1 n2*	
Example:	LIST:ADD:POINt 1 1	! Adds one additional point to point number 1 of list 1.
Description:	This command adds a point to list *n1* after point number *n2* (***NOTE:** The first point of the list is 1)*. When *n2* = 0, it inserts a point at the head of the list. The frequency, power, dwell time and modulation start of the added points are set to: a.) the same values as the point is inserted b.) the same values as the point it is inserted the instrument's minimum frequency, power, dwell time and modulation off if the list is empty.	

LIST:DELete:LIST

Syntax:	LIST:DELete:LIST *n*	
Example:	LIST:DELete:LIST 1	! Deletes all the points in list 1.
Description:	It clears all the points from the selected list.	

LIST:DELete:POINt

Syntax:	LIST:DELete:POINt *n1 n2*	
Example:	LIST:DELete:POINt 1 3	! Deletes point 3 of list 1
Description:	This command deletes point *n2* from list *n1*. After a point is deleted, the following points in the list are promoted to replace the one deleted *(**NOTE:** n2 = 1 denotes the first point in the list).*	

LIST:DWELl

Syntax:	LIST:DWELl <*Num_Val*>	
Example:	LIST:DWELl 100 MS	! Set the dwell time for current editing point in the current list 100 ms
Description:	This command sets the dwell time of the current editing point to *d*. The default value is in alternate values.	

LIST:DWELl:POINt

Syntax:	LIST:DWELl:POINt *n*	
Example:	LIST:DWELl:POINt 3	! Set edit point 3 as the current editing point.
Description:	This command sets the list point n as the current editing list point before modifying the dwell time. *(**NOTE:** LIST:DWELl:POINt should execute first to indicate which list point is going to modify).*	

LIST:DWELl:POINt?

Syntax:	LIST:DWELl:POINt?
Description:	This command returns the currently selected point for editing dwell time.

LIST:FREQuency:POINt

Syntax:	LIST:FREQuency:POINt *n*	
Example:	LIST:FREQuency:POINt 3	! Set list point 3 as the current editing point.
Description:	This command sets list point *n* as the current editing list point before modifying the frequency.	

LIST:FREQuency:POINt?

Syntax:	LIST:FREQuency:POINt?
Description:	This command returns the currently selected list point for frequency editing.

LIST:PRECompute?

Syntax:	LIST:PRECompute? *n*	
Example:	LIST:PRECompute? 1	! Performs precompute for list 1
Description:	This command calculates list *n*, and stores the calculated values in RAM. Return 0 when done. When the pre-calculated list is subsequently run, the first trace will run at full speed, since the instrument will not need to do the calculations as part of executing the first trace. All about 25 ms per point for this command.	

LIST:POWer

Syntax:	LIST:POWer <*Num_Val*>	
Example:	LIST:POWer -10	! Sets the current editing point in the current lists to -10 dB
Description:	This command specifies the power/amplitude points in the lists.	

LIST:POWer:POINt

Syntax:	LIST:POWer:POINt *n*
Example:	LIST:POWer:POINt 3
Description:	This command sets list point *n* as the current editing list point before modifying the power level.

LIST:POWer:POINt?

Syntax:	LIST:POWer:POINt?
Description:	This command returns the selected list point for power editing.

LIST:RANGe:ADD

Syntax:	LIST:RANGe:ADD *n*	
Example:	LIST:RANGe:ADD 1	! Inserts the range as list #1
Description:	This command inserts the list range as the given list number *n*. (***NOTE:** It takes about 10 ms per step to generate the list. Sufficient time must be given in the program for this task to complete).*	

LIST:RANGe:DWELl

Syntax:	LIST:RANGe:DWELl d [S | MS | US]	
Example:	LIST:RANGe:DWELl 100 MS	! Set the list dwell time range to 100 MS
Description:	This command sets the dwell time for each point in the list range set to *d*.	

LIST:RANGe:POWer

Syntax:	LIST:RANGe:POWer	
Example:	LIST:RANGe:POWer -3	! Set the list power range to -3 dBm
Description:	This command sets the power output for each point in the list range set to *d* (***NOTE:*** *The unit for the power level is dBm)*.	

LIST:RANGe:STARt

Syntax:	LIST:RANGe:STARt d [HZ |KZ | KHZ | MZ | MHZ | GZ | GHZ]	
Example:	LIST:RANGe:STARt 100 MHZ	! Se the start frequency of the list range to 100 MHZ
Description:	This command sets the start frequency for the list range to *d*.	

LIST:RANGe:STEP

Syntax:	LIST:RANGe:STEP [HZ |KZ | KHZ | MZ | MHZ | GZ | GHZ]	
Example:	LIST:RANGe:STEP 100 MHZ	! Se the step frequency of the list range to 100 MHZ
Description:	This command sets the step frequency for the list range to *d*.	

LIST:RANGe:STOP

Syntax:	LIST:RANGe:STOP [HZ |KZ | KHZ | MZ | MHZ | GZ | GHZ]	
Example:	LIST:RANGe:STOP 100 MHZ	! Se the stop frequency of the list range to 100 MHZ
Description:	This command sets the stop frequency for the list range to *d*.	

LIST:REPeat

Syntax:	LIST:REPeat SWEEp|STEP|CONTinuous	
Example:	LIST:REPeat STEP	! Sets the repeat mode for the current list to STEP
Description:	This command sets the repeat mode for the current running list to one of the followings: SWEEP, STEP or CONTINUOUS.	

LIST:RUN

Syntax:	LIST:RUN *n*	
Example:	LIST:RUN 2	! Set list 2 as the current running list
Description:	This command sets list *n* as the currently editing list.	

LIST:RUN?

Syntax:	LIST:RUN?
Description:	This command returns the current running list number.

LIST:TRIGger:SOURce

Syntax:	LIST:TRIGger:SOURce BNC | GPIB | IMMEdiate	
Example:	LIST:TRIGger:SOURce GPIB	! Sets the trigger condition for the current list to GPIB
Description:	This command sets the trigger condition for the current running list to one of the following sources: BNC, GPIB or IMMEDIATE.	

3.2.3.5 MARKer Subsystem Commands

- **MARKer:AOFF**
- **MARKer:AMPLitude**
- **MARKer:FREQuency**
- **MARKer:FREQuency?**
- **MARKer:POINt**
- **MARKer[:STATe]**

MARKer:AOFF

Syntax:	MARKer:AOFF	
Example:	MARKer:AOFF	! Turns off all the markers
Description:	This command turns off all markers.	

MARKer:AMPLitude

Syntax:	MARKer:AMPLitude <*Boolean*>	
Example:	MARKer:AMPLitude ON	! Set the Marker Amplitude ON
Description:	This command controls whether the marker affects the signal. If ON, the signal is modified when the marker frequency equals the output frequency. If OFF, only the marker output port is affected.	

MARKer:FREQuency

Syntax:	MARKer:FREQuency *d* [HZ | KZ | KHZ | MZ | MHZ | GZ | GHZ]	
Example:	MARKer:FREQuency 100 MHZ	! Set the selected marker frequency to 100 MHZ
Description:	This command sets the frequency for the specified mark to *d*.	

MARKer:FREQuency?

Syntax:	MARKer:FREQuency?
Description:	This command returns the frequency of the currently selected marker.

MARKer:POINt

Syntax:	MARKer:POINt *n*
Example:	MARKer: POINt 3
Description:	This command sets and turns on the marker to the specified sweep point.

MARKer[:STATe]

Syntax:	MARKer o	
Example:	MARKer ON	! Turns off the marker specified by the marker command header suffix
Description:	This command turns On/OFF the marker specified by the marker command header suffix.	

3.2.3.6 POWer Subsystem Commands

- **POWer:ATTenuation**
- **POWer:ALC[:STATe]**
- **POWer:ALC:SOURce:INTernal**
- **POWer[:LEVel][:IMMediate][:AMPlitude]**
- **POWer[:LEVel][:IMMediate][:AMPlitude]?**
- **POWer[:LEVel][:IMMediate][:Amplitude]:STEP**
- **POWer:MODE**
- **POWer:STARt**
- **POWer:STOP**

POWer:ATTenuation

Syntax:	POWer:ATTenuation <*Num_Val*>	
Example:	POWer:ATTenuation -10 DB	! Set the power attenuation to -10 dBm
Description:	This command sets the power attenuation level in dB	

POWer:ALC[:STATe]

Syntax:	POWer:ALC <*Boolean*>	
Example:	POWer: ALC ON	! Turn on the Automatic Leveling Control
Description:	This subsystem command enables or disables the Automatic Leveling Control of the generator.	

POWer:ALC:SOURce:INTernal

Syntax:	POWer:ALC:SOURce:INTernal DIODe | PMETer
Description:	This DIODe subsystem command directs the ALC feedback to be fed from an external diode detector. The PMETer subsystem command directs the ALC feedback to be fed from a power meter DC output.

POWer[:LEVel][:IMMediate][:AMPlitude]

Syntax:	POWer <*Num_Val*>	
Example:	POWer -10	! Set the unswept output signal to -10 dBm
Description:	This command sets the magnitude of the unswept output signal in terms of the current operating units. The units are the default value or can be set to a different value under the UNIT subsystem. The AMPLitude specifies the level for either a time varying or non-time varying signal.	

POWer[:LEVel][:IMMediate][:Amplitude]:STEP[:INCRement]

Syntax:	POWer:STEP <*Num_Val*>	
Example:	POWer:STEP -10	! Set the power step to -10 DB
Description:	This command specifies the power step size in dB for UP/DOWN incrementing.	

POWer[:LEVel][:IMMediate][:Amplitude]:STEP?

Syntax:	POWer:STEP?
Description:	This query form discovers the present step size.

POWer:MODE

Syntax:	POWer:MODE FIXed | SWEep | LIST	
Example 1:	POWer:MODE SWEep	! Set the SWEep commands to control the amplitude subsystem
Example 2:	POWer:MODE LIST	! Set the List commands to control the amplitude subsystem
Description:	This command establishes which set of commands will be used to control the amplitude subsystem. The settings have the following meanings:	
	FIXed:	The power amplitude is determined by the LEVel command under the appropriate subsystem.
	SWEep:	The source is in the swept mode and the amplitude is determined by STARt, STOP, CENTer, SPAN and MANual commands under the appropriate subsystem.
	LIST:	The source is in the LIST mode and the amplitude is determined by the appropriate amplitude list, such as LIST (refer to the LIST subsystem commands in this section).

POWer:STARt

Syntax:	POWer:STARt	
Example:	POWer:STARt 5	! Set the sweep starting power to 5 dB
Description:	This command sets the STARt power level. It also sets the lower limit of a manual sweep.	

POWer:STOP

Syntax:	POWer:STOP <*Num_Val*>	
Example:	POWer:STOP -7	! Set the sweep stop power level to -7 dB
Description:	This command sets the STOP power level. It also sets the upper limit of a manual sweep.	

3.2.3.7 **PULse Modulation Subsystem Commands** (Series 12500A/12700A Only)

- **PULSe:WIDTh?**
- **PULM:SOURce**
- **PULM:STATe**

PULSe:WIDTh?

Syntax:	PULSe:WIDTh?	
Example:	PULSe:WIDTh	! Query the width value
Description:	This command queries the width of the pulse.	

PULM:SOURce

Syntax:	PULM:SOURce EXTernal | INTernal	
Example:	PULM:SOURce EXTernal	! Select an EXTernal PM source
Description:	This command selects the source for modulating the signal; it may specify a single or multiple sources. The specified sources in the command are turned on. Any source from a previous selection are ignored. When multiple sources are available, individual INTernal sources may be distinguished by a unique numeric suffix. It as suffix is not added, the number 1 is assumed.	

PULM:STATe

Syntax:	PULM:STATe <*Boolean*>	
Example:	PULM:STATe ON (*or* OFF)	! Turn Pulse Modulation ON or OFF
Description:	This command turns Pulse Modulation ON or OFF Turning PM ON does not automatically turn OFF any other type of modulation.	

3.2.3.8 SWEep Subsystem Commands

- **SWEep:FREQuency:COUNt**
- **SWEep:FREQuency:DWELl**
- **SWEep:FREQuency:GENeration**
- **SWEep:FREQuency:STEP**
- **SWEep:FREQuency:TIME**
- **SWEep:POWer:COUNt**
- **SWEep:POWer:DWELl**
- **SWEep:POWer:STEP**
- **SWEep:POWer:TIME**

To use the SWEep:FREQuency and SWEep:POWer commands, first set the instrument to the appropriate control. Refer to :MODE under the FREQuency and POWer Subsystem Commands in earlier sections of this chapter.

SWEep:FREQuency:COUNt

Syntax:	SWEep:FREQuency:COUNt <*Num_Val*>	
Example:	SWEep:FREQuency:COUNt 10	! Set the number of sweeps to 10
Description:	This command determines the number of sweeps that will be enabled by a single trigger event. The default count is 1.	

SWEep:FREQuency:DWELl

Syntax:	SWEep:FREQuency:DWELl <*Num_Val*>	
Example:	SWEep:FREQuency:DWELl 10 NS	! Set the dwell time to 10 nanoseconds
Description:	This command controls the amount of time spent at each point during a sweep. *(**NOTE:** This value cannot exceed :TIME:POINts).*	

SWEep:FREQuency:GENeration

Syntax:	SWEep:FREQuency:GENeration STEPped | ANALog	
Example:	SWEep:FREQuency:GENeration ANALog	! Select an analog sweep
Description:	This command selects either a stepped or analog sweep.	

SWEep:FREQuency:STEP

Syntax:	SWEep:FREQuency:STEP <*Num_Val*>	
Example:	SWEep:FREQuency:STEP 10	! Set the STEP frequency to 10 HZ
Description:	This command controls the swept entity step size for a stepped linear sweep. This parameter is not used if generation is analog or if spacing is logarithmic.	

SWEep:FREQuency:TIME

Syntax:	SWEep:FREQuency:TIME <*Num_Val*>	
Example:	SWEep:FREQuency:TIME 10 MS	! Set the sweep duration to 10 microseconds
Description:	This command set the duration of the sweep. This command does not turn sweeping on.	

SWEep:POWer:COUNt

Syntax:	SWEep:POWer:COUNt <*Num_Val*>	
Example:	SWEep:POWer:COUNt 10	! Set the number of sweeps to 10
Description:	This command determines the number of sweeps that will be enabled by a single trigger event. The default count is 1.	

SWEep:POWer:DWELl

Syntax:	SWEep:POWer:DWELl <*Num_Val*>	
Example:	SWEep:POWer:DWELl 10 NS	! Set the dwell time to 10 nanoseconds
Description:	This command controls the amount of time spent at each point during a sweep. (***NOTE:*** *This value cannot exceed: TIME:POINts).*	

SWEep:POWer:STEP

Syntax:	SWEep:POWer:STEP <*Num_Val*>	
Example:	SWEep:POWer:STEP -5	! Set the power step time to -5 dB
Description:	This command controls the swept entity step size for a stepped power sweep.	

SWEep:POWer:TIME

Syntax:	SWEep:POWer:TIME <*Num_Val*>	
Example:	SWEep:POWer:TIME 10 MS	! Set the sweep duration to 10 microseconds
Description:	This command sets the duration of the sweep. This command does not turn sweeping on.	

3.2.3.9 SYSTem Subsystem Commands

- SYSTem:ERRor?
- SYSTem:PRESet

SYSTem:ERRor?

Syntax:	SYSTem:ERRor?
Description:	This command returns all error codes currently in the event status registers.

SYSTem:PRESet

Syntax:	SYSTem:PRESet
Description:	This command sets the synthesizer to the preset state.

3.2.3.10 TRIGger Subsystem Commands

- TRIGger:IMMediate
- TRIGger:SOURce

TRIGger:IMMediate

Syntax:	TRIGger:IMMediate
Description:	This command initiates an immediate sweep cycle and return to IDLE when complete. This command will have no effect if the cycle is set to CONTinuous.

TRIGger:SOURce

Syntax:	TRIGger:SOURce IMMediate | BUS | EXTernal	
Example:	TRIGger:SOURce IMM	! Set the TRIGger cycle to IMMediate
Description:	This command selects the source for the event. Only one source may be specified in the parameter at a time for a given event. The sources are:	
	IMM:	The event occurs immediately.
	BUS:	The source is signal-specific to the control interface.
	EXT:	An external signal jack is selected as the source. If no suffix is specified in the command, EXTernal is assumed.

3.2.4 SCPI Status Commands

All commands in Table 3-1 relate to the status monitoring system and read from and/or write to the various status group registers. The event and condition registers are read-only. The enable registers and transition filters are read/write. Each status group's transition filter actually contains two filters, one to detect positive-going transitions (PTR) and one to detect negative-going transitions (NTR). Data is in the form of a decimal number, which (when decoded to an 8-bit binary number) indicates the On/Off status of individual data bits.

Table 3-1: SCPI Status Commands

Keyword	Parameter Type	Initial Value	Query Form?
STATus :OPERation [:EVENt?]	none	none	query only
:CONDition?	none	none	query only
:ENABle	NUM	255	yes
:PTRansition	NUM	255	yes
:NTRansition	NUM	255	yes
The STATus:OPERation commands relate to the registers of the operational status group.			
STATus :QUEStionable	none	none	yes
[:EVENt?]	none	none	query only
:CONDition?	none	none	query only
:ENABle	NUM	255	yes
:PTRansition	NUM	255	yes
:NTRansition	NUM	255	yes
The STATus:QUEStionable commands relate to the registers of the questionable status group.			
STATus :QUEStionable :POWer	none	none	yes
[:EVENt?]	none	none	query only
:CONDition?	none	none	query only
:ENABle	NUM	255	yes
:PTRansition	NUM	255	yes
:NTRansition	NUM	255	yes
The STATus:QUEStionable:POWer commands relate to the registers of the questionable power status group.			
STATus :QUEStionable :POWer	none	none	yes
[:EVENt?]	none	none	query only
:CONDition?	none	none	query only
:ENABle	NUM	255	yes
:PTRansition	NUM	255	yes
:NTRansition			

Table 3-1: SCPI Status Commands (Continued)

Keyword	Parameter Type	Initial Value	Query Form?
The STATus:QUEStionable:POWer commands relate to the registers of the questionable power status group.			
STATus :QUEStionable :FREQuency	none	none	yes
[:EVENt?]	none	none	query only
:CONDition?	none	none	query only
:ENABle	NUM	255	yes
:PTRansition	NUM	255	yes
:NTRansition	NUM	255	yes
The STATus:QUEStionable:FREQuency commands relate to the registers of the questionable frequency status group.			
STATus :PRESet	none	none	no query
The STATus:PRESet command restores all parts of the status monitoring system to the power-on/reset condition.			
SYSTem :ERRor?			
The SYSTem:ERRor command reads the Error/Event Queue.			
TRIGger [:IMMediate]			
:SLOPe			
The trigger commands specify the execute mode (the method of triggering a process). The applicable process in the Series 50000B is a frequency sweep.			

3.2.5 Sample SCPI Commands

Table 3-2 shows some examples of brief SCPI commands.

Table 3-2: Sample SCPI Commands

Command	Meaning	Model	
		124XXA	125XXA/ 127XXA
*IDN?	Query instrument identification (response format: maker,model,serial#,firmware version) (Sample response: Giga-tronics,12000A,048256,75).	√	√
*RST	Reset system.	√	√
OUTP OFF	Turn off RF output.	√	√
AM:STAT OFF	Turn off external amplitude modulation.	N/A	√
AM:STAT?	Query external amplitude modulation (Sample response: 0).	N/A	√
POW -9.2	Set output power to -9.2 dBm.	√	√
POW?	Query output power (Sample response: -9.2).	√	√
FM:STAT OFF	Turn off external frequency modulation.	N/A	√
FM:STAT?	Query external frequency modulation (Sample response: 0).	N/A	√
FREQ 6.1GHZ	Set output frequency to 6.1 GHz	√	√
FREQ?	Query output frequency (Sample response: 6100000000).	√	√
PULM:STAT OFF	Turn off external pulse modulation.	N/A	√
PULM:STAT?	Query external pulse modulation (Sample response: 0).	N/A	√

3.3 Native Command Codes

Native Command Codes	Model	
	124XXA	125XXA/ 127XXA
3.3.1 - IEEE 488 Interface	√	√
3.3.2 - Command Syntax	√	√
3.3.3 - Native Command Code Set	√ (See Section for Restrictions)	√
3.3.4 - IEEE Common Commands	√ (N/A On Modulation)	√
3.3.5 - Fixed Frequency/Level Commands	√	√ (Ramp on Series 127XXA Only)
3.3.6 - List Mode Commands	√	√
3.3.7 - Manipulating Lists via GPIB	√	√
3.3.8 - Step Frequency Sweep Commands	√	√
3.3.9 - Ramp Frequency Sweep Commands (Series 12700A Only)	√	√
3.3.10 - Marker Commands	√	√
3.3.11 - Step Power Sweep Commands	√	√
3.3.12 - Ramp Power Sweep Commands (Series 12700A Only)	**N/A**	√
3.3.13 - Amplitude Modulation Commands	**N/A**	√
3.3.14 - Frequency Modulation Commands	**N/A**	√
3.3.15 - Pulse Modulation Commands	**N/A**	√
3.3.16 - Output Commands	√	√
3.3.17 - ALC Commands	√	√
3.3.18 - Instrument Control Commands	√	√

3.3.1 IEEE 488 Interface

The Series 12000A permits data bus control in accordance with the IEEE Standard Digital Interface for Programmable Instruments, IEEE STD 488.2. Table 3-3 shows the IEEE 488 standard subsets that are implemented in the 12000A.

Table 3-3: Implemented IEEE 488 Subsets

Subset	Title	12000A Implementation
SH1	Source Handshake	Complete Capability
AH1	Acceptor Handshake	Complete Capability
T8	Talker	Basic Talker
TE0	Extended Talker	No Capability
L4	Listener	Basic Listener
LE0	Extended Listener	No Capability
SR0	Service Request	No Capability
RL2	Remote/Local	Complete Capability
PP0	Parallel Poll	No Capability
DC0	Device Clear	No Capability
DT0	Device Trigger	No Capability
C0	Controller	No Capability

3.3.2 Command Syntax

The elements of the Series 12000A Native Interface Commands Codes are described in this section. Because some commands are included only for compatibility with earlier models, there are some variations in syntax from one command to another which must be carefully observed.

3.3.2.1 Function Codes

A native interface command includes a function code to indicate the nature and purpose of the command. Some commands contain a function code and nothing else. Commands consisting only of a function code are referred to in this manual as *simple* commands. However, most commands consist of a function code combined with other elements.

3.3.2.2 Address Assignment

The remote control address is assigned from the front panel of the instrument. The available range of addresses is 0 through 30.

3.3.2.3 Command Interpretation

The instrument uses a 40-character buffer to accept and store characters sent to it through the interface. Spaces are ignored. The buffer contents are interpreted and the buffer is reset upon receipt of a character sent with the EOI line asserted or upon receipt of any of the following delimiter characters:

`> > , : ; / \`

Multiple commands can be sent in a single message if they are separated from each other by a space or one of the delimiter characters. Each command will be interpreted individually upon receipt. If spaces are used to separate commands, care must be taken to assure that the 40-character buffer does not overflow. Buffer overflow can cause some commands to be ignored.

The 12000A can accept commands from a remote controller over the IEEE 488 interface or the RS-232 Serial port.

The 12000A syntax is designed to make the 12000A a compatible substitute for the HP 8340 in most remote-control operations. However, differences between the 12000A and the 8340 require some alteration of the 8340 command set; new commands are added, some existing commands differ slightly from their usual function when they are applied to the 12000A, and some existing commands are unsupported.

Commands in the Series 12000A syntax are represented in this publication by upper case letters. Some commands are followed by one or more lower case letters. These letters are interpreted as follows:

a   Indicates that alphanumeric characters are expected.

b   Indicates that one or more 8-bit bytes (entered in binary form) are expected.

d   Indicates that a decimal number is expected. Decimal numbers can be signed. Exponents may beindicated by an E; thus, +4.5E-6 represents 4.5x10-6.

h   Indicates that a hexadecimal number is expected.

n   Indicates that a single digit (0-9) is expected.

Terminator codes of HZ (Hz), KZ (kHz), MZ (MHz), GZ (GHz), DB (dB), DM (dBm), S (seconds), MS (ms), and US (μs) are used for many commands. Alternately, a comma or line feed can be used as a terminator; this causes the instrument to scale the corresponding function to the fundamental units of Hz, dB, dBm, or seconds.

The absence of lower case letters in a command indicates that the command is complete as shown, and requires no variables.

Commands with variables may be sent with either a space preceding the variable and/or terminator or with no space. For example: CW 12GZ, CW 12 GZ, CW12GZ, and CW12 GZ are all valid strings. If a command has multiple variables, they <u>must</u> be separated by a space.

A detailed description of many of the instrument functions may be found in Chapter 2 for all three models. Native instrument functions for the Series 125XXA/127XXA can be found at the end of the Chapter 2.

3.3.3 Native Command Code Set

Table 3-4 lists the IEEE 488.2 native commands that are implemented in the Series 12000A. Most of these codes do not stand alone; commands, prefixes, variables and suffixes must be combined with them. For further information refer to the sections cited in Table 3-4.

Table 3-4: 12000A Native Command Set

Command	Description	Section	Model	
			124XXA	125XXA/ 127XXA
Required Commands				
***CLS**	Clear status byte	3.3.4	√	√
***IDN?**	Ask for instrument ID		√	√
***OPC**	Operation complete command		√	√
***OPC?**	Operation complete query		√	√
***RST**	Software reset		√	√
***TRG**	System command initiates BUS triggered measurements.		√	√
/GTL	Go To Local for serial port		√	√
/NATive	Native language, from anywhere		√	√
/LLO	Local Lockout, for serial port		√	√
/SCPI	SCPI language, from anywhere		√	√
12000A Native Commands				
A n	Set ALC Mode	3.3.17	√	√
AD d	Set AM depth	3.3.3	**N/A**	√
AK n	Activate/deactivate marker amplitude	3.3.10	**N/A**	√
AM n	Activate/deactivate amplitude modulation	3.3.13	**N/A**	√
AMF n	Activate/deactivate amplitude modulation	3.3.13	**N/A**	√
AR d	Set internal AM rate (HZ,KZ,MZ,GZ)	3.3.13	**N/A**	√
AT d	ALC Set attenuator (DB)	3.3.17	√	√
AU	Set sweep time to shortest	3.3.9	√	√
CF d	Set CENTER Parameter (HZ,KZ,MZ,GZ)	3.3.9	√	√
CONTRAST d	Sets the LCD Contrast to the integer value specified.	3.3.18	√	√
CONTRAST?	Returns the current value of LCD Contrast.	3.3.18	√	√
CURLISTNUM?	Returns the current active List Number.	3.4.6	√	√
CURLISTPOINT?	Returns the current active List Point.	3.4.6	√	√

Table 3-4: 12000A Native Command Set (Continued)

Command	Description	Section	Model	
			124XXA	125XXA/ 127XXA
CS	Clear Status	3.3.18	√	√
CW d	Set CW frequency (HZ,KZ,MZ,GZ)	3.3.5	√	√
CW	Set GPIB active parameter	3.3.5	√	√
D1	Set repeat mode for step freq sweep to Continuous	3.3.8	√	√
D2	Set repeat mode for step freq sweep to Single-Sweep	3.3.8	√	√
D4	Set repeat mode for step freq sweep to Single-Step	3.3.8	√	√
DF d	Set SPAN parameter (HZ,KZ,MZ,GZ)	3.3.9	√	√
DN	Handle pressing step DOWN key	3.3.18	√	√
DU n	Specify GPIB screen	3.3.18	√	√
EF	Lock knob	3.3.18	√	√
EK	Unlock knob	3.3.18	√	√
ERR?	Error de-queue (use SCPI mechanism)	3.3.4	√	√
FA d	Set Start frequency (HZ,KZ,MZ,GZ)	3.3.9	√	√
FA	Set active parameter to start frequency	3.3.9	√	√
FB d	Set Stop parameter (HZ,KZ,MZ,GZ)	3.3.9	√	√
FB	Set active parameter to stop frequency	3.3.9	√	√
FC d	Set Sweep time (S,MS,US)	3.3.9	√	√
FC	Set active parameter to sweep time	3.3.9	√	√
FD d	Set FM deviation (HZ,KZ,MZ,GZ)	3.3.14	**N/A**	√
FM n	Activate/deactivate FM	3.3.14	**N/A**	√
FR d	Set internal FM rate (HZ,KZ,MZ,GZ)	3.3.14	**N/A**	√
FT n	Set FM mode	3.3.14	**N/A**	√
GA d	Set Start frequency (HZ,KZ,MZ,GZ)	3.3.8	√	√
GA	Set active parameter to start frequency	3.3.8	√	√
GB d	Set Stop frequency (HZ,KZ,MZ,GZ)	3.3.8	√	√
GB	Set active parameter to stop frequency	3.3.8	√	√
GC d	Set Step size (HZ,KZ,MZ,GZ)	3.3.8	√	√
GC	Set active parameter to step size	3.3.8	√	√
GD d	Set Dwell time (S,MS,US)	3.3.8	√	√

Table 3-4: 12000A Native Command Set (Continued)

Command	Description	Section	Model	
			124XXA	125XXA/ 127XXA
GD	Set active parameter to dwell time	3.3.8	√	√
IF	Increment CW frequency by minimum step size	3.3.5	√	√
IH	Initialize heap space to empty	3.3.18	√	√
IP	Instrument preset	3.3.18	√	√
L1	Set Repeat mode for list freq sweep to Continuous	3.3.6	√	√
L2	Set Repeat mode for list freq sweep to Single-Sweep	3.3.6	√	√
L4	Set Repeat mode for list freq sweep to Single-Step	3.3.6	√	√
LA n n	Add list point	3.3.6	√	√
LC n	Delete list	3.3.6	√	√
LD n n	Delete list point	3.3.6	√	√
LF n n d	Set frequency d of point n2 of list n1 (HZ,KZ,MZ,GZ)	3.3.6	√	√
LGA d	Set list point frequency (HZ,KZ,MZ,GZ)	3.3.6	√	√
LGB d	Set list range stop frequency (HZ,KZ,MZ,GZ)	3.3.6	√	√
LGC d	Set list range step size (HZ,KZ,MZ,GZ)	3.3.6	√	√
LGD d	Set list range dwell (HZ,KZ,MZ,GZ)	3.3.6	√	√
LGI n	Insert range as list number	3.3.6	√	√
LGL d	Set list range power output (DM)	3.3.6	√	√
LL n n d	Set list point power (DM)	3.3.6	√	√
LMA n n n	Set list point AM status	3.3.6	**N/A**	√
LMF n n n	Set list point FM status	3.3.6	**N/A**	√
LMP n n n	Set list point PM status	3.3.6	**N/A**	√
LR n	Run list	3.3.6	√	√
LS? n	Precompute list	3.3.6	√	√
LT n n d	Set list point dwell (S,MS,US)	3.3.6	√	√
M n d	Set marker frequency (HZ,KZ,MZ,GZ)	3.3.10	√	√
M0	Turn off last active marker	3.3.10	√	√
MC	Move last active marker to center sweep	3.3.10	√	√
MO	Turn off last active marker	3.3.10	√	√
NM	Cycle through FM modes	3.3.14	**N/A**	√

Table 3-4: 12000A Native Command Set (Continued)

Command	Description	Section	Model	
			124XXA	125XXA/ 127XXA
NSR	Never say remote - diagnostic command	3.3.18	√	√
OA	Output active parameter value	3.3.16	√	√
OC	Output start, center, time parameter for freq sweep	3.3.16	√	√
OD	Output diagnostic characters	3.3.16	√	√
OGI	Make OI respond with Giga-tronics info	3.3.16	√	√
OI	Output identification	3.3.16	√	√
OPAS	Output lock and level flag	3.3.16	√	√
OPCF	Output center frequency parameter value	3.3.16	√	√
OPCW	Output CW frequency value	3.3.16	√	√
OPDF	Output data frequency parameter value (span)	3.3.16	√	√
OPFA	Output start frequency parameter value	3.3.16	√	√
OPFB	Output stop frequency parameter value	3.3.16	√	√
OPM n	Output Marker frequency value	3.3.16	√	√
OPPL	Output CW level value	3.3.16	√	√
OPSF	Output CW frequency step value	3.3.16	√	√
OR	Output CW level value	3.3.16	√	√
OS	Output Lock and Level value in binary	3.3.16	√	√
P1	Set Repeat parameter for ramp power sweep to Continuous	3.3.12	**N/A**	√ (127XXA Only)
P2	Set Repeat parameter for ramp power sweep to Single-Sweep	3.3.12	**N/A**	√ (127XXA Only)
P3	Set Repeat parameter for ramp power sweep to stop	3.3.12	**N/A**	√ (127XXA Only)
PA d	Set Start parameter (DM)	3.3.12	√	√
PB d	Set Stop Parameter (DM)	3.3.12	√	√
PC d	Set sweep time	3.3.12	√	√
PH2	Lock Hi-power module on	3.3.18	√	√
PI	Select Pulse Interval	3.3.15	**N/A**	√
PL d	Set CW power level	3.3.5	√	√
PL d	Set GPIB active parameter (DM)	3.3.5	√	√

Table 3-4: 12000A Native Command Set (Continued)

Command	Description	Section	Model	
			124XXA	125XXA/ 127XXA
PM n	Activate/deactivate pulse modulation	3.3.15	N/A	√
PR d	Set internal PM rate (HZ,KZ,MZ,GZ)	3.3.15	N/A	√
PS n	Activate/deactivate power sweep	3.3.12	√	√
PW d	Set internal PM width (S,MS,US)	3.3.15	N/A	√
PWV n	Select Pulse waveform	3.3.15	N/A	√
PY d	Set internal PM delay (S,MS,US)	3.3.15	N/A	√
Q1	Set repeat mode for Step Power Sweep to Continuous	3.3.11	√	√
Q2	Set repeat mode for Step Power Sweep to Single-Sweep	3.3.11	√	√
QA d	Set Start parameter (DM)	3.3.11	√	√
QB d	Set Stop parameter (DM)	3.3.11	√	√
QC d	Set Step parameter (DB)	3.3.11	√	√
QD d	Set Dwell parameter (S,MS,US)	3.3.11	√	√
RC n	Recall setup	3.3.18	√	√
RF n	Turn RF off or on	3.3.5	√	√
RFD n	RF on/off @ frequency change	3.3.18	√	√
RS	Re-start sweep	Multiple	√	√
S1	Set Repeat parameter for ramp freq sweep to Continuous	3.3.9	N/A	√
S2	Set Repeat parameter for ramp freq sweep to Single-Sweep	3.3.9	N/A	√ (127XXA Only)
S3	Set Repeat parameter for ramp freq sweep to stop	3.3.9	N/A	√ (127XXA Only)
SC n	Activate/deactivate Scan modulation	3.3.13	N/A	√
SCPI	Switch to SCPI language		√	√
SD d	Set depth for Scan modulation or variable attenuation (DB)	3.3.13	N/A	√
SF d	Set CW frequency resolution	3.3.5	√	√
SG	Set Repeat parameter Single-sweep	3.3.9	√	√
SHA1	Select unleveled mode (disable ALC)	3.3.17	√	√
SHCW d	Set CW frequency step size (HZ,KZ,MZ,GZ)	3.3.5	√	√
SHM4 d	Run self-test program (HZ,KZ,MZ,GZ)	3.3.18	√	√

Table 3-4: 12000A Native Command Set (Continued)

Command	Description	Section	Model	
			124XXA	125XXA/ 127XXA
SHPL d	Set CW power step size (DB)	3.3.5	√	√
SHPM	Activate external PM for Model 8757A	3.3.15	**N/A**	√
SHPS d	Uncouple and set attenuator	3.3.17	√	√
SHRF	Select unleveled mode (Disable ALC)	3.3.17	√	√
SHRL	Re-Couple Attenuator	3.3.17	√	√
SHS n	Display blanked	3.3.18	√	√
SHSL d	Uncouple and set attenuator	3.3.17	√	√
SM	Stop sweep and permit incremental adjustment	3.3.8	√	√
SN d	Set Step count parameter	3.3.8	√	√
SP d	Set CW power resolution	3.3.5	√	√
SR d	Set rate for scan modulation (HZ,KZ,MZ,GZ)	3.3.13	**N/A**	√
ST d	Set ramp power and frequency sweep time (S,MS,US)	3.3.9	**N/A**	√ (127XXA Only)
ST	Set GPIB active parameter	3.3.9	√	√
SV n	Store setup	3.3.18	√	√
TR n	Set sweep trigger	Multiple	√	√
TS	Set sweep parameter to Single Sweep	3.3.9	√	√
UO t	Update flash parameter block	TBA	√	√
UP	Handle pressing step UP key	3.3.18	√	√

3.3.4 IEEE Common Commands

IEEE Common Commands	Model	
	124XXA	125XXA/ 127XXA
ERR?	√	√
***IDN?**	√	√
***RST**	√ (Modulation Items N/A)	√
***TRG**	√	√

These commands perform functions as defined in the IEEE 488.2 standard.

ERR?

Syntax:	ERR?
Response:	Returns the error number and a description of the error: e.g., 107,"Frequency above maximum; maximum frequency is 20.1 GHz" (e.g. following a CW40GZ command).
Description:	This command reports the next entry in the instrument's error queue. There may be up to 20 messages in the queue; the messages are reported out oldest first. The error report consists of an error number followed by a description of the error. If the error queue is empty, the error report is **0, No error**. If the queue fills up, the last (newest) error report is replaced with **350, Queue overflow**.

*IDN?

Syntax:	*IDN?
Description:	The instrument identification string can be requested with this command. The following string will be returned: Giga-tronics, model number, serial number, version and build number, such as Giga-tronics, 12520A, 992604, 1.05-44.5.

*RST

Syntax:	*RST	
Description:	This command will cause the instrument to reset. The reset conditions are:	
	Frequency:	Minimum
	Level:	0 dBm
	ALC:	Internal
	Atten:	Automatic
	Modulation:	*All Off*
	AM:	*Ext @ 90%*
	FM:	*Ext @ 2 KHz*
	Pulse:	*Ext + True*

*TRG

Syntax:	*TRG
Description:	*TRG is a system level common command that initiates BUS triggered measurements. It has the same effect as a Group Execute Trigger (GET) when received, parsed and executed.

3.3.5 Fixed Frequency/Level Commands

Fixed Frequency/Level Commands	Model	
	124XXA	125XXA/ 127XXA
CW	√	√
IF	√	√
PL	√	√ (Ramp on 127XXA Only)
RF	√	√
SF	√	√
SP	√	√
SHCW	√	√
SHPL	√	√

These commands set or control parameters to operate the instrument in fixed frequency and/or fixed output level modes.

CW

Syntax:	CW *d* [HZ | KZ | MZ | GZ]	
Example:	CW 12 GZ	! Set the frequency to 12 GHz
		! CW Puts the instrument into CW mode
Description:	This command puts the instrument into CW mode and sets the CW frequency to *d* [HZ | KZ | MZ | GZ]. Here *d* is a decimal number with possible decimal point and/or exponent and [HZ | KZ | MZ | GZ] is an optional terminator denoting the units in which *d* is expressed. No terminator implies Hz. (***NOTE:*** *If the CW command is sent with no variable the instrument will return to CW mode at the last frequency entered).*	

IF

Syntax:	IF
Example:	N/A
Description:	This command will increment the CW frequency by the minimum resolvable step. This is normally 0.1 Hz, unless Option 36 (1 kHz resolution) is present.

PL

Syntax:	PL *d* DM	
Example:	PL -6.2 DM	! Set power to -6.2 dBm
Description:	This command sets the CW power d dBm. The CW power is used during CW mode, step frequency sweep and ramp frequency sweep.	

RF

Syntax:	RF n	
Example:	RF 1	! Turns RF on
Description:	This command sets the RF output of the instrument. Send RF 1 turns on the RF; Sending RF 0 turns off the RF.	

SF

Syntax:	SF *d terminator*	
Example:	SF 50 MZ	! Set frequency resolution to 50 MHz
Description:	This command puts the instrument into CW mode and sets the frequency resolution to *d* [HZ | KZ | MZ | GZ]. Here d is a decimal number with possible decimal point and/or exponent and [HZ | KZ | MZ | GZ] is an optional terminator denoting the units d is expressed in. No terminator implies Hz. This resolution variable determines the increments generated by turning the knob or pressing the up/down buttons.	

SP

Syntax:	SP *d terminator*	
Example:	SP 5 DB	! Set power resolution to 5 dB
Description:	This command puts the instrument into CW mode and sets the power resolution to *d* dB. Here *d* is a decimal number with possible decimal point and/or exponent and DB is the terminator. This resolution variable determines the increments generated by turning the knob or pressing the up/down buttons.	

SHCW

Syntax:	SHCW *d terminator*	
Example:	SHCW 50 MZ	! Set frequency resolution to 50 MHz
Description:	This command puts the instrument into CW mode and sets the frequency resolution to *d* [HZ | KZ | MZ | GZ]. Here *d* is a decimal number with possible decimal point and/or exponent and [HZ | KZ | MZ | GZ] is an optional terminator denoting the units *d* is expressed in. No terminator implies Hz. This resolution variable determines the increments generated by turning the knob or pressing the up/down buttons. This command is included for compatibility with Hewlett Packard (Agilent) scalar analyzers.	

SHPL

Syntax:	SHPL *d terminator*	
Example:	SHPL 5 DB	! Set power resolution to 5 dB
Description:	This command puts the instrument into CW mode and sets the power resolution to *d* dB. Here *d* is a decimal number with possible decimal point and/or exponent and DB is the terminator. This resolution variable determines the increments generated by turning the knob or pressing the up/down buttons.	

3.3.6 List Mode Commands

List Mode Commands	Model	
	124XXA	125XXA/ 127XXA
L*n*	√	√
LA	√	√
LC	√	√
LD	√	√
LF	√	√
LGA	√	√
LGB	√	√
LGC	√	√
LGD	√	√
LGI	√	√
LGL	√	√
LL	√	√
LR	√	√
LS?	√	√
LT	√	√
TR	√	√
CURLISTNUM?	√	√
CURLISTPOINT?	√	√

These commands control the operation of the instrument is the List Mode. List Mode is specifically designed to provide the fastest frequency and level switching speeds. Each list is a set of frequencies in any arbitrary order. Power level, dwell and modulation parameters may be set for each frequency. Refer to Section 3.3.7 for additional details.

L1

Syntax:	L1
Example:	N/A
Description:	This command causes the List Mode to run continuously once the LR command has been issued. Continuous repeat mode supports Immediate, Trigger in BNC and Softkey triggers (See TR commands).

L2

Syntax:	L2
Example:	N/A
Description:	This command causes the List Mode to run once before stopping after the LR command has been issued. When the list is exhausted, the frequency remains at the frequency of the last point. Single Sweep mode supports Immediate, Trigger in BNC and Softkey triggers (See TR commands).

L4

Syntax:	L4
Example:	N/A
Description:	This command causes the List Mode to take a single step-to the next list point-in response to a trigger once the LR command has been issued. The first trigger sets the frequency to the first point in the list being run. Subsequent triggers advance the frequency to the next list point. When the last point in the list is reached, the next trigger returns the frequency to the first point in the list. Single Step mode supports Trigger in BNC and Softkey triggers (See TR commands). *(**NOTE:** The L4 Command modifies Trigger Type setting to Softkey/GPIB (Command TR1). For Trigger In BNC trigger type, the TR0 Command must follow L4).*

LA

Syntax:	LA *n1 n2*	
Example:	LA 2 6	! Adds a point to list 2 after point number 6
Description:	Adds a point to list *n1* after point number *n2*.	
	n2 = 1	is the first list
	n2 = 1	is the first point in the list. Set n2 = 0 to insert a point at the head of the list. The frequency, power, dwell and modulation status of the added point are set to: a) the same values as the point it is inserted after, or b)
	if n2 =	0, to the same values as the point it is inserted before, or c) if the list is empty, to the instrument's minimum frequency, 0.00 dBm, 100 ms, modulation off.
	***NOTE:** The LA command only establishes the point. It is then necessary to send the LF, LL, LT and LMx commands to set any parameters which need to be changed.*	

LC

Syntax:	LC *n*	
Example:	LC 1	! Clears List number 1
Description:	The LC command will clear all the points from the selected list.	

LD

Syntax:	LD *n1 n2*	
Example:	LD 2 6	! Delete point 6 from List number 2
Description:	Deletes point *n2* from list *n1*. *n2* = 1 denotes the first point in the list; *n1* = 1 denotes the first list. After a point is deleted, the following points in the list are promoted to replace the one deleted.	

LF

Syntax:	LF *n n d* [HZ | KZ | MZ | GZ]	
Example:	LF 2 6 5 GZ	! Set point 6 in List 2 to 5 GHz
Description:	Sets the frequency for point n2 of list n1 to *d* [HZ | KZ | MZ | GZ], where *d* is the frequency (a decimal number with possible decimal point and/or exponent) and [HZ | KZ | MZ | GZ] is the units in which the frequency is expressed. No terminator implies Hz. The LGA through LGL list range commands allow automatic generation of a list of frequencies starting at a given point, with a fixed increment, and ending at a given point. This effectively creates a digital (step) sweep, but permits flexible editing techniques of the list mode. A common dwell and level may be set for the range	

LGA

Syntax:	LGA *d* (HZ|KZ|MZ|GZ)	
Example:	LGA 2 GZ	! Set list range start to 2 GHz
Description:	The start frequency for the list range is set with this command.	

LGB

Syntax:	LGB *d* (HZ|KZ|MZ|GZ)	
Example:	LGB 12 GZ	! Set list range stop to 12 GHz
Description:	The stop frequency for the list range is set with this command.	

LGC

Syntax:	LGC *d* (HZ|KZ|MZ|GZ)	
Example:	LGC 1 MZ	! Set list range step size to 1 MHz
Description:	The step size for the list range is set with this command.	

LGD

Syntax:	LGD *d* (S|MS|S)	
Example:	LGD 25 MS	! Set list range dwell to 25 mS
Description:	The dwell time for each point in the list range is set with this command.	

LGI

Syntax:	LGI *n*	
Example:	LGI 1	! Insert the range as list #1
Description:	This command inserts the list range as the given list number. *(**NOTE:** It takes about 10 mS per step to generate the list. Sufficient time must be given in the program for this task to complete)*.	

LGL

Syntax:	LGL *d* DM	
Example:	LGL -3 DM	! Set list range power to -3 dBm
Description:	The power output for each point of the list range is set with this command.	

LL

Syntax:	LL *n1 n2 d* DM	
Example:	LL 2 6 -3.5 DM	! Set point 6 in List 2 to -3.5 dBm
Description:	Sets the power level for point *n2* of list *n1* to *d* DM, where *d* is the power level (a decimal number with possible decimal point and/or exponent) in dBm.	

LR

Syntax:	LR *n*	
Example:	LR 2	! Start List number 2 running
Description:	Starts List Mode running list *n*. The type of list (e.g. Continuous, Single Sweep, or Single Step) is determined by what L( ) command has been sent. *(**NOTE:** The status of the TR( ) command will determine if the List starts immediately or is triggered. To stop List Mode, send the CW command)*.	

LS?

Syntax:	LS? *n*	
Example:	LS? 2	! Set up List number 2
Description:	Does the calculations for list *n*, and stores the calculated values in RAM. Returns 0 when done. When the pre-calculated list is subsequently run, the first trace will run at full speed, since the instrument will not need to do the calculations as part of executing the first trace. Allow about 25 mS per point for this command.	

LT

Syntax:	LT *n1 n2 d* [S | MS | US]	
Example:	LT 2 6 20 MS	! Set the dwell for List 2, point 6 to 20 ms
Description:	Sets the dwell time for point *n2* of list *n1* to *d* [S | MS | US], where *d* is the dwell time (a decimal number with possible decimal point and/or exponent) and [S | MS | US] are the units for the dwell time. S is seconds, MS is milliseconds, and US is microseconds. No terminator implies seconds.	

TR

Syntax:	TR *n*	
Example:	TR 2	! Sets the current list trigger to immediate
Description:	Sets the trigger condition for the current list as specified by the value *n:*	
	n = 0	Sets the trigger condition for the current list to **Trigger in BNC**. This will stop the current point as its current point until the Trigger In BNC is pulsed, at which time the list will go to its first point and begin running (single step will take one step for each trigger). The BNC trigger is supported for all repeat modes: continuous, single sweep and single step.
	n = 1	Sets the trigger condition for the current list to *Softkey or GPIB*. Setting this trigger type stops the current list until the soft key is pressed or the GPIB GET is received, at which time the list will go to its first point and begin running (single sweep will take one step for each trigger). The soft key trigger is supported for all repeat modes: continuous, single sweep and single step.
	n = 2	Sets the trigger to **Immediate** - i.e., no trigger condition; the list will begin as soon as it is run. Because single-set repeat requires a trigger, an immediate trigger is not valid for a single-step sweep or a single-step list mode.

CURLISTNUM?

Syntax:	CURLISTNUM?
Example:	CURLISTNUM?
Description:	This command returns the current active List number.

CURLISTPOINT?

Syntax:	CURLISTPOINT?
Example:	CURLISTPOINT?
Description:	This command returns the current active List Point.

3.3.7 Manipulating Lists via GPIB

The following is an example of a sample script for list mode:

```
IP
??##1000  mSec.
DU 3
LA 1,0
LL 1,1,15.0000 DM
LF 1,1,5.0 GZ
LT 1,1, 10 us
LA 1,1
LL 1,2,10.0000 DM
LF 1,2,6.0 GZ
LA 1,2
LL 1,3,5.0000 DM
LF 1,3,7.0 GZ
LS? 1
??##1000  mSec.
RF 1
L4
TR 0
LR 2
```

3.3.7.1 Controlling List Execution

List execution is governed by the "LR n", "TR n" and "Ln" commands:

- The TR n command specifies the conditions that begin, or trigger, list execution. Valid values of 'n', and their meanings, are:
  - 0 – trigger from the external trigger input
  - 1 – trigger from a GPIB GET event or from the front panel's List menu's trigger softkey
  - 2 – trigger immediately
- The Ln command specifies the conditions that stop list execution. Valid values of 'n', and their meanings, are:
  - 0 - Continuous: Execute the entire current list, repeating it indefinitely.
  - 2 - Single Sweep: Execute the entire current list, and then stop; the next trigger will resume execution at the start of the list.
  - 4 - Single Step: Execute the current list point, and then stop; the next trigger will resume execution with the next list point. The list's first point is considered to be the initial current point, and is also considered to be the point following the list's final point.
- The LR n command simply designates which list is the current list, i.e. is to be executed; it does not itself automatically cause list execution to commence, unless of course the most recent Ln command was L0.

3.3.7.2 List Entry Speed Up

The manipulation (adding, editing, deleting) of large numbers of list points can be speeded up by changing the list trigger mode from the default mode (immediate) to a non-immediate one, e.g.:

- TR 0

This will relieve the 12000A's firmware of the burden of repeatedly terminating and relaunching list execution in response to each command's arrival, leaving it free to devote itself entirely to command processing. After the list points are manipulated, and their lists precompiled, the trigger mode can be changed as desired.

3.3.7.3 List Precompilation

In the 12000A, list points exist in two different forms. One is the *source* form, where the data describing a point is in a form that closely corresponds to the human readable formats used by the front panel's list menu and the GPIB Lxxx commands. Source form points are *compiled* to create corresponding *object* form points, which are in a format that is understandable to the 12000A's actual signal generation hardware. Normally, compilation is performed during list execution; while point N of a list is being output by the hardware, point N+1 is being compiled by the firmware. The process is invisible to the user, as long as the dwell times of list points are longer than their compilation time (currently about 25 ms a piece). If point dwell times are lower than this value, list execution will be 'slow':

- At the end of a point's dwell time, list execution will pause until next point's compilation is completed
- If Config | Retrace is set to RF Off, then RF will be blanked during this period
- If List | Repeat Mode is set to Single Step, trigger events may be missed

To enable real-time execution of lists with 'short' dwell times, the 12000A contains a feature known as *list precompilation*, which is implemented via the "LS? n" native mode GPIB command. The basic procedure is as follows, using list #3 as an example:

1. Add and/or edit the list's points, e.g.

   ```
   LA    3,0
   LF    3,1,1 GZ
   LL    3,1,0 DM
   LT    3,1,100 MS
   etc.
   ```

2. Issue "LS? 3"

3. Allow adequate time for the list to compile.

4. Read the command's response ("0", i.e. zero) from the GPIB bus.

The list may then be executed after first specifying it as the current list, via an LR 3 command.

Precompilation may need to be repeated whenever:

- Points are added to or removed from the list
- Points are edited
- The unit's AC line power is cycled

3.3.7.4 Multiple Precompiled Lists

The 12000A also supports the precompilation of multiple lists. This can be done by following the single list precompilation procedure for each list of interest; alternately:

1. Add and/or edit all the points for all the lists.
2. Issue an LS? command (and await and read the response therefrom) for each list.

Execution of multiple precompiled lists is somewhat more involved. Instead of simply issuing an LR n command for a given list, it is necessary to issue the LS? n / read bus / LR n sequence, e.g.:

1. Add/edit list #2's points.
2. Add/edit list #7's points.
3. Issue LS? 2 / wait / read bus.
4. Issue LS? 7 / wait / read bus.
5. Issue LR 7.
6. Execute list 7 via whatever triggering.
7. Issue LS? 2 / read bus / LR 2.
8. Execute list 2 via whatever triggering.
9. Issue LS? 7 / read bus / LR 7.
10. Execute list 7 via whatever triggering.

☛ ***NOTE:*** *In steps 7 and 9, no 'wait' was specified. This is because the LS? n command's execution is lengthy only when a list needs to be recompiled; if the list was previously compiled and does not require recompilation, the command will execute quickly.*

3.3.7.5 List Points Storage

The 12000A allocates storage for list points from pools of memory; thus, the storage requirement for a given number of list points is largely independent of the number of lists in which they are placed. For example, a single list of 100 points requires about the same amount of storage as 10 lists of 10 points each.

Source form points are allocated from nonvolatile memory, so that they will be preserved across cyclings of the unit's AC line power, i.e. across *line power sessions*. This pool of memory is shared by unit setups that are saved via the front panel's System | Store button; nevertheless, there is sufficient space for several thousand points. Object form list points are allocated from volatile memory, i.e. they do not persist beyond the current line power session. Many aspects of the unit's functionality share this pool of memory; therefore, the allocation of an excessive number of object form list points may impair other aspects of the unit's behavior. Deletion of object form list points (See next page) may replenish this pool to a state suitable to these other aspects; however, only the cycling of line power is guaranteed to effect a complete replenishment. Currently, we recommend that the number of object form list points be limited to 1000.

The following lists of circumstances are given to help the user insure that the limit on object point quantities can be observed.

Events causing allocation of source form points include:

- The adding of a point (LA n command)

Events causing their deallocation include:

- The removal of a point (LD n1 n2 command)
- The deletion of an entire list (LC n command)
- Receipt of the IH or IP commands
- Any other event that causes the clearing of nonvolatile memory

Events causing allocation of object form points include:

- The editing of a source form point (LF, LL, LT, etc. commands)
- The precompilation of a list (LS? n command)
- The running of a list that is not precompiled (LR n command)

Events causing their deallocation include:

- The deletion of a source form list (LC n command)
- The cycling of line power

☛ ***NOTE:*** *Lists, when edited or executed, consume object form points, regardless of whether they are precompiled. Also note that the only way to recycle object form points during a given line power session is to delete an entire source form list, via the LC n command.*

3.3.7.6 Precompiling Saved Lists

Currently, the 12000A exhibits a glitch in the precompilation and subsequent execution of lists that were input to the unit during a previous line power session (and thus automatically saved in nonvolatile memory). The workaround is as follows:

1. Create a single point list having a fairly long dwell time, and suitable power and frequency, e.g.:
   - LA 100,0
   - LT 100,1,10 S
2. Issue an LR n command for the list, e.g.:
   - LR 100
3. Change the list trigger mode to 'immediate', e.g.:
   - TR 2
   - L1
4. Wait a moment.
5. Change the list trigger mode to a non-immediate form, e.g.:
   - L2
   - TR 0

This workaround procedure should be executed prior to precompiling and subsequently executing the saved list(s) of interest.

3.3.8 Step Frequency Sweep Commands

The following commands control the operation of the instrument during Step Frequency Sweep. This mode of operation permits stepping the frequency between two points with a user defined step size and dwell time. Step Frequency Sweep provides discrete increments of frequency.

Step Frequency Sweep Commands	Model	
	124XXA	125XXA/ 127XXA
D*n*	√	√
GA	√	√
GB	√	√
GC	√	√
GD	√	√
RS	√	√
SM	√	√
SN	√	√
TR	√	√

D1

Syntax:	D1
Example:	N/A
Description:	Puts step frequency sweep into continuously sweeping mode. If a step frequency sweep was not running, starts it running; if it was running, restarts the sweep. *(**NOTE:** The various sweep parameters (e.g. start, stop, dwell) must have been previously set).*

D2

Syntax:	D2
Example:	N/A
Description:	Puts step frequency sweep into single sweep mode. If a step frequency sweep was not running, starts it running; if it was running, restarts the sweep. *(**NOTE:** The various sweep parameters (e.g. start, stop, dwell) must have been previously set).*

D4

Syntax:	D4
Example:	N/A
Description:	Puts step frequency sweep into single step mode. If a step frequency sweep was not running, starts it running; if it was running, restarts the sweep. *(**NOTE:** The various sweep parameters (e.g. start, stop, dwell) must have been previously set).*

GA

Syntax:	GA *d* [HZ | KZ | MZ | GZ]	
Example:	GA 5 GZ	! Set the step frequency start to 5 GHz
Description:	Sets the start frequency for a step frequency sweep to *d* [HZ | KZ | MZ | GZ], where *d* is the frequency (a decimal number with possible decimal point and/or exponent) and [HZ | KZ | MZ | GZ] is the units in which the frequency is expressed. No terminator implies Hz. If a step frequency sweep was not running, starts it running; if it was running, restarts the sweep. If the GA command is sent with no variable it makes the step frequency sweep start frequency the active variable. If a step frequency sweep was not running, starts it running; if it was running, restarts the sweep	

GB

Syntax:	GB *d* [HZ | KZ | MZ | GZ]	
Example:	GB 8 GZ	! Set the step frequency stop to 8 GHz
Description:	Sets the stop frequency for a step frequency sweep to *d* [HZ | KZ | MZ | GZ], where *d* is the frequency (a decimal number with possible decimal point and/or exponent) and [HZ | KZ | MZ | GZ] is the units in which the frequency is expressed. No terminator implies Hz. If a step frequency sweep was not running, starts it running; if it was running, restarts the sweep. (***NOTE:*** *If the GB command is sent with no variable it makes the step frequency sweep stop frequency the active variable. If a step frequency sweep was not running, starts it running; if it was running, restarts the sweep).*	

GC

Syntax:	GC *d* [HZ | KZ | MZ | GZ]	
Example:	GC 12.5 MZ	! Set the step frequency sweep step size to 12.5 MHz
Description:	Sets the step size for a step frequency sweep to d [HZ | KZ | MZ | GZ], where d is the frequency (a decimal number with possible decimal point and/or exponent) and [HZ | KZ | MZ | GZ] is the units in which the frequency is expressed. No terminator implies Hz. If a step frequency sweep was not running, starts it running; if it was running, restarts the sweep. *(**NOTE**: If the GC command is sent with no variable it makes the step frequency step size the active variable. If a step frequency was not running, starts it running; if it was running, restarts the sweep).*	

GD

Syntax:	GD *d* [S | MS | US]	
Example:	GD 25 MS	! Set the step frequency dwell time to 25 ms
Description:	Sets the dwell time for a step frequency sweep to *d* [S | MS | US], where *d* is the frequency (a decimal number with possible decimal point and/or exponent) and [S | MS | US] is the units in which the frequency is expressed. No terminator implies S. If a step frequency sweep was not running, starts it running; if it was running, restarts the sweep. If the GD command is sent with no variable it makes the step frequency sweep dwell time the active variable. If a step frequency sweep was not running, starts it running; if it was running, restarts the sweep.	

RS

Syntax:	RS
Example:	N/A
Description:	This command restarts the current Sweep or List mode. The sweep is interrupted and reset to the start frequency. All other parameters remain unchanged.

SM

Syntax:	SM
Example:	N/A
Description:	The SM command is only meaningful if a sweep is in process. When received, the sweep is interrupted and manual control (knob, keypad, or up/down buttons) of the frequency or power (if a power sweep) is enabled. The sweep may be restarted using a softkey on the sweep menu.

SN

Syntax:	SN *d*	
Example:	SN 20	! Activate step frequency sweep, start/steps Mode, with 20 steps.
Description:	The SM command is only meaningful if a sweep is in process. When received, the sweep is interrupted and manual control (knob, keypad, or up/down buttons) of the frequency or power (if a power sweep) is enabled. The sweep may be restarted using a softkey on the sweep menu.	

TR

Syntax:	TR *n*	
Example:	TR 2	! Sets the current sweep trigger to immediate
Description:	Sets the trigger condition for the current sweep as specified by the value *n:*	
	n = 0	Sets the trigger condition for the current sweep to **Trigger in BNC**. This will stop the current sweep at its current point until the Trigger In BNC is pulsed, at which time the list will go to its first point and begin running (single step will take one step for each trigger). The BNC trigger is supported for all repeat modes: continuous, single sweep and single step.
	n = 1	Sets the trigger condition for the current list to *Softkey or GPIB.* Setting this trigger type stops the current list until the soft key is pressed or the GPIB GET is received, at which time the sweep will go to its starting condition and begin running (single sweep will take one step for each trigger). The soft key trigger is supported for all repeat modes: continuous, single sweep and single step.
	n = 2	Sets the trigger to **Immediate** - i.e., no trigger condition; the sweep will begin as soon as it is run. Because single-step repeat mode requires a trigger, an immediate trigger is not valid for a single-step or a single-step list mode.

3.3.9 Ramp Frequency Sweep Commands (Series 12700A Only)

The Ramp Frequency Sweep mode (also known as Analog Sweep) produces a linear change in frequency over a specified time period. The sweep is defined between two frequency points. Although the frequency is actually a series of discrete steps, the steps are sufficiently small that the net result appears to be continuous.

Ramp Frequency Sweep Commands	Model	
	124XXA	125XXA/ 127XXA
AU	N/A	√
CF	N/A	√
DF	N/A	√
FA	N/A	√
FB	N/A	√
FC	N/A	√
RS	N/A	√
S*n*	N/A	√
SG	N/A	√
ST	N/A	√
TR	N/A	√
TS	N/A	√

AU

Syntax:	AU	
Example:	N/A	
Description:	This command automatically sets the sweep time to the shortest possible using the start and stop frequencies as the determining parameters. Since the instrument uses a frequency division scheme for frequencies below 4 GHz, the shortest allowable sweep times are a function of the division in use.	

CF

Syntax:	CF *d* [Hz | KZ | MZ | GZ]	
Example:	CF 4 GZ	! Activates Ramp Sweep with a 4 GHz Center Frequency
Description:	Sets the center for a Ramp Frequency Sweep to *d* [HZ | KZ | MZ | GZ], where *d* is the center frequency (a decimal number with possible decimal point and/or exponent) and [HZ | KZ | MZ | GZ] is the units in which the frequency is expressed. No terminator implies Hz. If a Ramp Frequency Sweep was not running, starts it running; if it was running, restarts the sweep.	

DF

Syntax:	DF *d* [HZ | KZ | MZ | GZ]	
Example:	DF 5 GZ	! Activates Ramp Sweep with a 5 GHz Delta Sweep
Description:	Sets the center for a Ramp Frequency Sweep to *d* [HZ | KZ | MZ | GZ], where *d* is the center frequency (a decimal number with possible decimal point and/or exponent) and [HZ | KZ | MZ | GZ] is the units in which the frequency is expressed. No terminator implies Hz. If a Ramp Frequency Sweep was not running, starts it running; if it was running, restarts the sweep.	

FA

Syntax:	FA *d* [HZ | KZ | MZ | GZ]	
Example:	FA 5 GZ	! Set the Ramp Frequency start to 5 GHz
Description:	Sets the start frequency for a Ramp Frequency Sweep to *d* [HZ | KZ | MZ | GZ], where *d* is the frequency (a decimal number with possible decimal point and/or exponent) and [HZ | KZ | MZ | GZ] is the units in which the frequency is expressed. No terminator implies Hz. If a Ramp Frequency Sweep was not running, starts it running; if it was running, restarts the sweep. If the FA command is sent with no variable it makes the Ramp Frequency Sweep start frequency the active variable. If a Ramp Frequency Sweep was not running, starts it running; if it was running, restarts the sweep.	

FB

Syntax:	FB *d* [HZ | KZ | MZ | GZ]	
Example:	FB 8 GZ	! Set the Ramp Frequency stop to 8 GHz
Description:	Sets the stop frequency for a Ramp Frequency Sweep to *d* [HZ | KZ | MZ | GZ], where *d* is the frequency (a decimal number with possible decimal point and/or exponent) and [HZ | KZ | MZ | GZ] is the units in which the frequency is expressed. No terminator implies Hz. If a Ramp Frequency Sweep was not running, starts it running; if it was running, restarts the sweep. If the FB command is sent with no variable it makes the Ramp Frequency Sweep stop frequency the active variable. If a Ramp Frequency Sweep was not running, starts it running; if it was running, restarts the sweep.	

FC

Syntax:	FC *d* [S | MS | US]	
Example:	FC 25 MS	! Set the Ramp Frequency Sweep time to 25 ms
Description:	Sets the time for a Ramp Frequency Sweep to *d* [S | MS | US], where *d* is the frequency (a decimal number with possible decimal point and/or exponent) and [S | MS | US] is the units in which the frequency is expressed. No terminator implies seconds. If a Ramp Frequency Sweep was not running, starts it running; if it was running, restarts the sweep. If the FC command is sent with no variable it makes the Ramp Frequency Sweep time the active variable. If a Ramp Frequency Sweep was not running, starts it running; if it was running, restarts the sweep.	

RS

Syntax:	RS
Example:	N/A
Description:	This command restarts the current Sweep. The sweep is interrupted and reset to the start frequency. All other parameters remain unchanged.

S1

Syntax:	S1
Example:	N/A
Description:	Puts Ramp Frequency Sweep into continuously sweeping mode. If a Ramp Frequency Sweep was not running, starts it running; if it was running, restarts the sweep. *(**NOTE:** The various sweep parameters (e.g. start, stop, time) must have been previously set).*

S2

Syntax:	S2
Example:	N/A
Description:	Puts Ramp Frequency Sweep into single sweep mode. If a Ramp Frequency Sweep was not running, starts it running; if it was running, restarts the sweep. *(**NOTE:** The various sweep parameters (e.g. start, stop, time) must have been previously set).*

S3

Syntax:	S3
Example:	N/A
Description:	This command stops the Ramp Frequency Sweep. The frequency may now be adjusted manually.

SG

Syntax:	SG
Example:	N/A
Description:	Puts Ramp Frequency Sweep into single sweep mode. If a Ramp Frequency Sweep was not running, starts it running; if it was running, restarts the sweep. *(**NOTE:** The various sweep parameters (e.g. start, stop, time) must have been previously set).*

ST

Syntax:	ST *d* [S | MS | US]
Example:	ST 100 US ! Set the Ramp Sweep time to 100 ms
Description:	Sets the time for a Ramp Frequency Sweep to *d* [S | MS | US], where *d* is the frequency (a decimal number with possible decimal point and/or exponent) and [S | MS | US] is the units in which the frequency is expressed. No terminator implies seconds. If a Ramp Frequency Sweep was not running, starts it running; if it was running, restarts the sweep.

TR

Syntax:	TR *n*	
Example:	TR 2	! Sets the current sweep trigger to immediate
Description:	Sets the trigger condition for the current sweep as specified by the value *n:*	
	n = 0	Sets the trigger condition for the current sweep to **Trigger in BNC**. This will stop the current sweep at its current point until the Trigger In BNC is pulsed, at which time the list will go to its first point and begin running (single step will take one step for each trigger). The BNC trigger is supported for all repeat modes: continuous, single sweep and single step.
	n = 1	Sets the trigger condition for the current list to *Softkey or GPIB.* Setting this trigger type stops the current sweep until the soft key is pressed or the GPIB GET is received, at which time the sweep will go to its starting condition and begin running (single sweep will take one step for each trigger). The soft key trigger is supported for all repeat modes: continuous, single sweep and single step.
	n = 2	Sets the trigger to **Immediate** - i.e., no trigger condition; the sweep will begin as soon as it is run. Because single-step repeat mode requires a trigger, an immediate trigger is not valid for a single-step or a single-step sweep.

TS

Syntax:	TS
Example:	N/A
Description:	Puts Ramp Frequency Sweep into single sweep mode. If a Ramp Frequency Sweep was not running, starts it running; if it was running, restarts the sweep. *(**NOTE:** The various sweep parameters (e.g. start, stop, time) must have been previously set).*

3.3.10 Marker Commands

Markers are provided during frequency sweeps to allow identifying specific points along the sweep. This set of commands permits marker assignment and selection.

Marker Commands	Model	
	124XXA	125XXA/ 127XXA
AK	√	√
M0	√	√
M *n d*	√	√
MC	√	√
MO	√	√

AK

Syntax:	AK *n*	
Example:	AK 1	! Turn on the Amplitude Marker
Description:	AK 1 activates and AK 0 deactivates a function which causes a 3 dB drop in the RF output power to occur at marker frequencies.	

M0

Syntax:	M0
Example:	N/A
Description:	This command deactivates the marker that was last activated.

M *n d*

Syntax:	M *n d* [HZ | KZ | MZ | GZ]	
Example:	M 5 7.2 GZ	! Activates marker 5 at 7.2 GHz
Description:	Each of the eight available markers may individually be activated and set to a particular frequency using this command. To turn off a particular marker, first activate it using M5 then send the command.	

MC

Syntax:	MC
Example:	N/A
Description:	Places the last activated marker at the sweep center frequency.

MO

Syntax:	MO
Example:	N/A
Description:	This command deactivates the marker that was last activated.

3.3.11 Step Power Sweep Commands

The following commands control the operation of the instrument during Step Power Sweep. This mode of operation permits stepping the power between two points with a user defined step size and dwell time. Step Power Sweep provides discrete increments of Power.

Step Power Sweep Commands	Model	
	124XXA	125XXA/ 127XXA
Q1	√	√
Q2	√	√
QA	√	√
QB	√	√
QC	√	√
QD	√	√
RS	√	√
TR	√	√

Q1

Syntax:	Q1
Example:	N/A
Description:	Puts Step Power Sweep into a continuously sweeping mode. If a step power sweep was not running, starts it running, if it was running, restarts the sweep. *(**NOTE:** The various sweep parameters (i.e., start, stop, dwell) must have been previously set).*

Q2

Syntax:	Q2
Example:	N/A
Description:	Puts Step Power Sweep into a single sweeping mode. If a step power sweep was not running, starts it running, if it was running, restarts the sweep. *(**NOTE:** The various sweep parameters (i.e., start, stop, dwell) must have been previously set).*

QA

Syntax:	QA *d* DM	
Example:	QA 2 DM	! Set the Step Power Sweep start to 2 dBm
Description:	Sets the start power for a Step Power Sweep to *d* [DM], where *d* is the power (a decimal number with possible decimal point and/or exponent) and [DM] is the units terminator. If a Step Power Sweep was not running, starts it running; if it was running, restarts the sweep. If the QA command is sent with no variable it makes the Step Power Sweep start power the active variable. If a Step Power Sweep was not running, starts it running; if it was running, restarts the sweep	

QB

Syntax:	QB *d* DM	
Example:	QB 8 DM	! Set the Step Power Sweep stop 8 dBm
Description:	Sets the stop power for a Step Power Sweep to *d* [DM], where *d* is the power (a decimal number with possible decimal point and/or exponent) and [DM] is the units terminator. If a Step Power Sweep was not running, starts it running; if it was running, restarts the sweep. If the QB command is sent with no variable it makes the Step Power Sweep stop power the active variable. If a Step Power Sweep was not running, starts it running; if it was running, restarts the sweep.	

QC

Syntax:	QC *d* DM	
Example:	QC .1 DB	! Set the Step Power Sweep step to .1 dB
Description:	Sets the step size for a Step Power Sweep to *d* [DB], where *d* is the power (a decimal number with possible decimal point and/or exponent) and [DB] is the units terminator. If a Step Power Sweep was not running, starts it running; if it was running, restarts the sweep. If the QC command is sent with no variable it makes the Step Power Sweep step size the active variable. If a Step Power Sweep was not running, starts it running; if it was running, restarts the sweep	

QD

Syntax:	QD *d* [S | MS | US]	
Example:	QD 5 MS	! Set the Step Power Sweep dwell to 5 ms
Description:	Sets the dwell time for a Step Power Sweep to d [S | MS | US], where *d* is the time (a decimal number with possible decimal point and/or exponent) and [S | MS | US] is the units terminator. If a Step Power Sweep was not running, starts it running; if it was running, restarts the sweep. If the QC command is sent with no variable it makes the Step Power Sweep step size the active variable. If a Step Power Sweep was not running, starts it running; if it was running, restarts the sweep .	

RS

Syntax:	RS
Example:	N/A
Description:	This command restarts the current Sweep. The sweep is interrupted and reset to the start frequency. All other parameters remain unchanged.

TR

Syntax:	TR *n*	
Example:	TR 2	! Sets the current sweep trigger to immediate
Description:	Sets the trigger condition for the current sweep as specified by the value *n*:	
	n = 0	Sets the trigger condition for the current sweep to **Trigger In BNC**. This will stop the current sweep until the Trigger In BNC is pulsed, at which time the sweep will go to its starting condition and begin running (single step will take one step for each trigger). The BNC trigger is supported for all repeat modes: continuous, single sweep and single step.
	n = 1	Sets the trigger condition for the current sweep to *Softkey or GPIB*. Setting this trigger type stops the current sweep until the soft key is pressed or the GPIB GET is received, at which time the sweep will go to its starting condition and begin running (single step will take one step for each trigger). The soft key trigger is supported for all repeat modes: continuous, single sweep and single step.
	n = 2	Sets the trigger to **Immediate** - i.e., no trigger condition; the sweep will begin as soon as it is run. Because single-step repeat mode requires a trigger, an immediate trigger is not valid for a single-step sweep.

3.3.12 Ramp Power Sweep Commands (Series 12700A Only)

The Ramp Power Sweep mode (also known as Analog Power Sweep) produces a linear change in power over a specified time period. The sweep is defined between two power levels. Although the power is actually a series of discrete steps, the steps are sufficiently small that the net result appears to be continuous.

Ramp Power Sweep Commands (Series 12700A Only)	Model	
	124XXA	125XXA/ 127XXA
P*n*	N/A	√
PA	N/A	√
PB	N/A	√
PC	N/A	√
PS	N/A	√
RS	N/A	√
TR	N/A	√

P1

Syntax:	P1
Example:	N/A
Description:	Puts Ramp Power Sweep into continuously sweeping mode. If a Ramp Power Sweep was not running, starts it running; if it was running, this command restarts the sweep. *(**NOTE:** The various sweep parameters (e.g. start, stop, time) must have been previously set).*

P2

Syntax:	P2
Example:	N/A
Description:	Puts Ramp Power Sweep into single sweep mode. If a Ramp Power Sweep was not running, starts it running; if it was running, this command restarts the sweep. *(**NOTE:** The various sweep parameters (e.g. start, stop, time) must have been previously set).*

P3

Syntax:	P3
Example:	N/A
Description:	Sending this command will cause the Ramp Power Sweep to stop. The power may now be adjusted manually.

PA

Syntax:	PA *d* DM	
Example:	PA 2 DM	! Set the Ramp Power Sweep start to 2 dBm
Description:	Sets the start power for a Ramp Power Sweep to *d* [DM], where *d* is the power (a decimal number with possible decimal point and/or exponent) and [DM] is the units terminator. If a Ramp Power Sweep was not running, the PA command starts it running and; if it was running, restarts the sweep. If the PA command is sent with no variable it makes start power the active variable. If a Ramp Power Sweep was not running, the PA command starts it running and; if it was running, restarts the sweep.	

PB

Syntax:	PB *d* DM	
Example:	PB 8 DM	! Set the Ramp Power Sweep stop to 8 dBm
Description:	Sets the stop power for a Ramp Power Sweep to *d* [DM], where *d* is the power (a decimal number with possible decimal point and/or exponent) and [DM] is the units terminator. If a Ramp Power Sweep was not running, the PB command starts it running and; if it was running, restarts the sweep. If the PB command is sent with no variable, it makes stop power the active variable. If a Ramp Power Sweep was not running, the PB command starts it running and; if it was running, restarts the sweep.	

PC

Syntax:	PC *d* [S | MS | US]	
Example:	PC 5 MS	! Set the Ramp Power Sweep time to 5 ms
Description:	Sets the time for a Ramp Power Sweep to *d* [S | MS | US], where *d* is the time (a decimal number with possible decimal point and/or exponent) and [S | MS | US] is the units terminator. If a Ramp Power Sweep was not running, the PC command starts it running and; if it was running, restarts the sweep. If the PC command is sent with no variable it makes Power Sweep time the active variable. If a Ramp Power Sweep was not running, the PC command starts it running and; if it was running, restarts the sweep.	

PS

Syntax:	PS	
Example:	PS 1	! Activate Ramp Power Sweep
Description:	This command activates (PS 1) or deactivates (PS 0) the Ramp Power Sweep.	

RS

Syntax:	RS
Example:	N/A
Description:	This command restarts the current Sweep. The sweep is interrupted and reset to the start frequency. All other parameters remain unchanged.

TR

Syntax:	TR *n*	
Example:	TR 2	! Sets the current sweep trigger to immediate
Description:	Sets the trigger condition for the current sweep as specified by the value *n*:	
	n = 0	Sets the trigger condition for the current sweep to **Trigger In BNC**. This will stop the current sweep until the Trigger In BNC is pulsed, at which time the sweep will go to its starting condition and begin running (single step will take one step for each trigger). The BNC trigger is supported for all repeat modes: continuous, single sweep and single step.
	n = 1	Sets the trigger condition for the current sweep to *Softkey or GPIB*. Setting this trigger type stops the current sweep until the soft key is pressed or the GPIB GET is received, at which time the sweep will go to its starting condition and begin running (single step will take one step for each trigger). The soft key trigger is supported for all repeat modes: continuous, single sweep and single step.
	n = 2	Sets the trigger to **Immediate** - i.e., no trigger condition; the sweep will begin as soon as it is run. Because single-step repeat mode requires a trigger, an immediate trigger is not valid for a single-step sweep.

3.3.13 Amplitude Modulation Commands (Series 12500A/12700A Only)

The Amplitude Modulation command set selects of the source of modulation and the modulation depth. If Option 24 is installed, the various parameters of the internal generator are able to be set.

Amplitude Modulation Commands (Series 12500A/12700A Only)	Model	
	124XXA	125XXA/ 127XXA
AD	N/A	√
AM	N/A	√
AMF	N/A	√
AR	N/A	√
SC	N/A	√
SD	N/A	√
SR	N/A	√

AD

Syntax:	AD *d*	
Example:	AD 40	! Set the AM depth to 40%
Description:	Sets the depth of Amplitude Modulation to *d* percent.	

AM

Syntax:	AM *n*	
Example:	AM 1	! Activate external AM
Description:	Sets the trigger condition for the current sweep as specified by the value *n*:	
	n = 0	Deactivate (turn off) Amplitude Modulation.
	n = 1	Activate external Amplitude Modulation.
	n = 2	Activate internal Amplitude Modulation **(Only with Option 24)** and select sine wave.
	n = 3	Activate internal Amplitude Modulation **(Only with Option 24)** and select square wave.
	n = 4	Activate internal Amplitude Modulation **(Only with Option 24)** and select triangle wave.
	n = 5	Activate internal Amplitude Modulation **(Only with Option 24)** and select positive ramp.
	n = 6	Activate internal Amplitude Modulation **(Only with Option 24)** and select negative ramp.
	n = 7	Activate internal Amplitude Modulation **(Only with Option 24)** and select noise.
	n = 8	Activate internal Amplitude Modulation **(Only with Option 24)** and select zero output.

AMF

Syntax:	AMF *n*	
Example:	AMF 1	! Activate external AM
Description:	The AMF set of commands duplicate the functions of the AM commands listed above. This command group is included for compatibility with older Giga-tronics instruments.	

AR

Syntax:	AR *d* [Hz | KZ | MZ |GZ]	
Example:	AR 400 HZ	! Set the internal AM rate to 400 Hz
Description:	Sets the rate of the internal amplitude modulation generator to *d* [Hz | KZ | MZ |GZ]. **This command is valid only with Option 24.**	

SC

Syntax:	SC *n*	
Example:	SC 1	! Activate external Scan AM
Description:	Activates and selects the source of the Scan AM according to the following values for *n*:	
	n = 0	Deactivate (turn off) Scan Amplitude Modulation.
	n = 1	Activate external Scan Amplitude Modulation **(Only with Option 29)**.
	n = 2	Activate internal Scan Amplitude Modulation **(Only with Options 24 and 29)** and select sine wave.
	n = 3	Activate internal Scan Amplitude Modulation **(Only with Options 24 and 29)** and select square wave.
	n = 4	Activate internal Scan Amplitude Modulation **(Only with Options 24 and 29)** and select triangle wave.
	n = 5	Activate variable attenuation. In this mode no internal or external signal is applied. The setting of the Scan depth ([SD]) determines the amount of attenuation provided.
	n = 6	Activate internal scan **(Only with Options 24 and 29)** and select positive ramp.
	n = 7	Activate internal scan **(Only with Options 24 and 29)** and select negative ramp.
	n = 8	Activate internal scan **(Only with Options 24 and 29)** and select noise.
	n = 9	Activate internal scan **(Only with Options 24 and 29)** and select zero output.

SD

Syntax:	SD *d*	
Example:	SD 40	! Set the Scan depth to 40 dB
Description:	Sets the depth of Amplitude Modulation to *d* dB. (***NOTE:*** *The AM source needs to be set prior to using this command since the external depth and internal depth are independent variables.*	

SR

Syntax:	SR *d* [HZ | KZ | MZ | GZ]	
Example:	SR 400 HZ	! Set the internal AM rate to 400 Hz
Description:	Sets the rate of the internal amplitude modulation generator to *d* [HZ | KZ | MZ | GZ]. **This command is valid only with Options 24 and 29**.	

3.3.14 Frequency Modulation Commands (Series 12500A/12700A Only)

The Frequency Modulation command set selects of the source of modulation and the modulation deviation. If Option 24 is installed, the various parameters of the internal generator are able to be set.

Frequency Modulation Commands (Series 12500A/12700A Only)	Model	
	124XXA	125XXA/ 127XXA
FD	N/A	√
FM	N/A	√
FR	N/A	√
FT	N/A	√
NM	N/A	√

FD

Syntax:	FD *d* [HZ | KZ | MZ | GZ]	
Example:	FD 500 KZ	! Activate FM with a 500 kHz deviation
Description:	Allows setting the deviation to *d* [HZ | KZ | MZ | GZ], where *d* is the power (a decimal number with possible decimal point and/or exponent) and [HZ | KZ | MZ | GZ] is the units terminator. If the FM mode is Phase, then this command sets the deviation in Radians (with any units key the terminator).	

FM

Syntax:	FM *n*	
Example:	FM 1	! Activate External FM
Description:	Activates and selects the source of the FM according to the following values for *n*. (***NOTE:*** *This command applies to Narrow, Wide and Phase modes. See the FT command)*.	
	n = 0	Deactivate (turn off) Frequency Modulation.
	n = 1	Activate external Frequency Modulation.
	n = 2	Activate internal Frequency Modulation **(Only with Option 24)** and select sine wave.
	n = 3	Activate internal Frequency Modulation **(Only with Option 24)** and select square wave.
	n = 4	Activate internal Frequency Modulation **(Only with Option 24)** and select triangle wave.
	n = 5	Activate internal Frequency Modulation **(Only with Option 24)** and select positive ramp.
	n = 6	Activate internal Frequency Modulation **(Only with Option 24)** and select negative ramp.
	n = 7	Activate internal Frequency Modulation **(Only with Option 24)** and select zero output.

FR

Syntax:	FD *d* [HZ | KZ | MZ | GZ]	
Example:	FD 400 KZ	! Set the internal FM rate to 400 Hz
Description:	Sets the rate of the internal frequency modulation generator to *d* [Hz | KZ | MZ |GZ]. **This command is valid only with Option 24.**	

FT

Syntax:	FT *n*	
Example:	FT 1	! Set the FM to Narrow mode
Description:	This command sets the mode for Frequency Modulation. The following modes are available for the value of *n*:	
	1 =	Narrow mode
	2 =	Wide mode

NM

Syntax:	NM	
Example:	N/A	! Toggle to the next FM mode
Description:	This command sets the FM mode to the next type. Available types are: Narrow, Wide, Phase, Narrow and Phase Wide.	

3.3.15 Pulse Modulation Commands (Series 12500A/12700A Only)

The Pulse Modulation command set selects of the source of modulation and the delay. If Option 24 is installed, the various parameters of the internal generator are able to be set.

Pulse Modulation Commands (Series 12500A/12700A Only)	Model	
	124XXA	125XXA/ 127XXA
PM	N/A	√
PR	N/A	√
PW	N/A	√
PWV	N/A	√
PY	N/A	√
PI	N/A	√
SHPM	N/A	√

PM

Syntax:	PM *n*	
Example:	PM 1	! Activate External PM
Description:	Activates and selects the source of the FM according to the following values for *n*. ((***NOTE:*** *This command applies to Narrow, Wide and Phase modes. See the FT command)*.	
	n = 0	Deactivate (turn off) Pulse Modulation.
	n = 1	Activate external positive true Pulse Modulation.
	n = 2	Activate internal Pulse Modulation **(Only with Option 24)**.
	n = 3	Activate external negative true Pulse Modulation.
	n = 4	Activate external rising edge trigger Pulse Modulation (**Only with Option 24)**.
	n = 5	Activate external falling edge trigger Pulse Modulation **(Only with Option 24)**.

PR

Syntax:	PR *d* [HZ | KZ | MZ | GZ]	
Example:	PR 500 KZ	! Set PM rate to 500 kHz
Description:	Sets the rate to *d* [HZ | KZ | MZ | GZ], where *d* is the frequency (a decimal number with possible decimal point and/or exponent) and [HZ | KZ | MZ | GZ] is the units terminator. **This command requires Option 24 to be installed.** The internal modulation generator does not allow the rate and start delay to be sent independently. If the PR command is sent, the start delay is adjusted to produce the desired rate. The pulse width and interval delays are adjustable within the requested period (1/rate).	

PW

Syntax:	PW *d* [S | MS | US]	
Example:	PW 5 MS	! Set PM width to 5 ms
Description:	Sets the width for an internally generated PM signal to *d* [S | MS | US], where *d* is the time (a decimal number with possible decimal point and/or exponent) and [S | MS | US] is the units terminator. **This command requires Option 24 to be installed.** If rate has been selected, the pulse width is adjustable only within the requested period (1/rate).	

PWV

Syntax:	PWV *n*	
Example:	PWV 1	! Activate singlet waveform
Description:	Selects the waveform generated by the internal pulse modulation generator according to the following values for *n*:	
	n = 0	Selects no waveform.
	n = 1	Selects singlet waveform.
	n = 2	Selects doublet waveform.
	n = 3	Selects triplet waveform.
	n = 4	Selects quadlet waveform.

PI

Syntax:	PI *d* [S | MS | US]	
Example:	PI 5 MS	! Set 5 ms interval delay
Description:	Sets the interval display between pulses (doublet, triplet, quadlet) generated by the internal pulse modulation generator, where d is the time (a decimal number with possible decimal point and/or exponent) and [S | MS | US] is the units terminator. **This command requires Option 24 to be installed**.	

PY

Syntax:	PY *d* [S | MS | US]	
Example:	PY 5 MS	! Set PM delay to 5 ms
Description:	Sets the delay for an externally triggered or internally generated PM signal to *d* [S | MS | US], where *d* is the time (a decimal number with possible decimal point and/or exponent) and [S | MS | US] is the units terminator. **This command requires Option 24 to be installed.** The internal modulation generator does not allow the rate and start delay to be sent independently. If the PY command is sent, the period of repetition becomes a function of the star delay, pulse width, interval delay, and waveform type (singlet, doublet, etc.) as follows: *start delay + ((pulse width + interval delay)(number of pulses))*	

SHPM

Syntax:	SHPM
Example:	N/A
Description:	This command is included for compatibility with systems using Hewlett Packard (Agilent) model 8757A scalar analyzers. It will turn on external Pulse Modulation.

3.3.16 Output Commands

This series of commands allows a remote controller to read the values of many of the instrument parameters. The returned string is a decimal number expressed in base units (Hz for frequency, seconds for time, dBm for power). See examples following. Note that this series of commands causes the instrument output buffer to be loaded with the desired result. The remote controller must then do a read to obtain the data.

Output Commands	Model	
	124XXA	125XXA/ 127XXA
OA	√	√
OC	√	√
OD	√	√
OI	√	√
OPAS	√	√
OPCF	√	√
OPCW	√	√
OPDF	√	√
OPFA	√	√
OPFB	√	√
OPM	√	√
OPPL	√	√
OPSF	√	√
OR	√	√

OA

Syntax:	OA
Example:	OA
Response:	Returns a string showing the value of the active variable.
Response Example:	9000000000.0 (Frequency of 9 GHz)
Description:	Whenever a command is sent to change a parameter, that parameter becomes the active variable. Sending the OA command will then return the value of that variable.

OC

Syntax:	OC
Example:	OC
Response:	Returns a string containing first the start frequency, the center frequency, and last the sweep time. A space separates each value.
Response Example:	9000000000.0 12000000000.0 .005
Description:	This command outputs the coupled parameters found in center/delta frequency sweeps. The above example shows a sweep starting at 9 GHz, with a 12 GHz center frequency, and a sweep time of 5 ms.

OD

Syntax:	OD
Example:	OD
Response:	Returns a string containing the self test result. If the test failed, it returns a failure message with the frequency that caused the failure.
Response Example:	1 1 1 0 0
Description:	This command outputs the results of instrument self-test (See SHM4). The self-test steps the instrument across its frequency range and checks for lock and level at each step.The OD command must be sent following self-test to send the string.

OI

Syntax:	OI
Example:	OI
Description:	This command outputs the instrument's identification.

OPAS

Syntax:	OPAS *d*
Example:	N/A
Description:	This command outputs the Lock, Level and Calibration status. A "1" represents Locked, leveled, or calibrated respectively; a "0" represents unlocked, unleveled, or un-calibrated respectively.

OPCF

Syntax:	OPCF
Example:	OPCF
Response:	Returns a string containing the center frequency of a sweep.
Response Example:	9000000000.0 (A center frequency of 9 GHz)
Description:	When the instrument is operating in a Frequency Sweep mode, this command will output the value of the sweep center frequency.

OPCW

Syntax:	OPCW
Example:	OPCW
Response:	Returns a string containing the current CW frequency.
Response Example:	4500000.0 (A CW frequency of 4.5 MHz)
Description:	The value of the current value of the CW frequency will be returned, even if the instrument is in a different mode.

OPDF

Syntax:	OPDF
Example:	OPDF
Response:	Returns a string containing the delta frequency of a sweep.
Response Example:	6000000000.0 (A delta sweep value of 6 GHz)
Description:	When the instrument is operating in a Frequency Sweep mode, this command will output the value of the sweep delta frequency.

OPFA

Syntax:	OPFA
Example:	OPFA
Response:	Returns a string containing the start frequency of a sweep.
Response Example:	2500000000.0 (A start frequency of 2.5 GHz)
Description:	When the instrument is operating in a Frequency Sweep mode, this command will output the value of the sweep start frequency.

OPFB

Syntax:	OPFB
Example:	OPFB
Response:	Returns a string containing the stop frequency of a sweep.
Response Example:	6500000000.0 (A start frequency of 6.5 GHz)
Description:	When the instrument is operating in a Frequency Sweep mode, this command will output the value of the sweep stop frequency.

OPM

Syntax:	OPM *n*
Example:	OPM 3
Response:	Returns a string with the value for the selected marker frequency.
Response Example:	5552000.0 (Marker 3 at a frequency of 5.552 MHz)
Description:	This command allows interrogating each of the twelve markers to determine the frequency to which it is set. Send OPM *n* where *n* is the marker number.

OPPL

Syntax:	OPPL
Example:	OPPL
Response:	Returns a string containing the value of the output power in dBm.
Response Example:	-15.3 (An output power of -15.3 dBm)
Description:	The value of the current value of the fixed output power will be returned, even if the instrument is in a different mode (e.g. step power sweep).

OPSF

Syntax:	OPSF
Example:	OPSF
Response:	Returns a string containing the center frequency of a sweep.
Response Example:	100.0 (A step size of 100 Hz)
Description:	When the instrument is operating in a Frequency Sweep mode, this command will output the value of the sweep center frequency.

OR

Syntax:	OR
Example:	OR
Response:	Returns a string containing the value of the output power in dBm.
Response Example:	-15.3 (An output power of -15.3 dBM)
Description:	The value of the current value of the fixed output power will be returned, even if the instrument is in a different mode (e.g. step power sweep). This command is identical in operation to OPPL and is included for compatibility with older Hewlett Packard (Agilent) instruments.

3.3.17 ALC Commands

ALC Commands	Model	
	124XXA	125XXA/ 127XXA
A	√	√
AT	√	√
SHA1	√	√
SHPS	√	√
SHRF	√	√
SHSL	√	√
SHRL	√	√

A

Syntax:	A *n*	
Example:	A 1	! Selects Internal Leveling
Description:	Selects the leveling method according to the following values for *n*.	
	n = 1	Selects Internal Leveling.
	n = 2	Selects External Leveling using a negative diode detector. **CURRENTLY NOT SUPPORTED**.
	n = 3	Selects External Leveling using the DC output of a power meter. **CURRENTLY NOT SUPPORTED**.

AT

Syntax:	AT *d* DB	
Example:	AT80DB	! Sets the attenuator to 80 dB
Description:	Sets the attenuator independently of the level control, in 10 dB increments, from 0 to 110 dB. To use this command, the attenuator must first be uncoupled from the level control by sending SHSL. When using this command, the level control can independently adjust the input level to the step attenuator from at least -10 to +15 dBm with the PL command. This now allows the RF output level to be varied over approximately 25 dB without the step attenuator switching.	

SHA1

Syntax:	SHA1
Example:	N/A
Description:	This mode disables the automatic level control. It is included for compatibility with older Hewlett Packard (Agilent) instruments.

SHPS

Syntax:	SHPS *d* DB	
Example:	SHPS80DB	! Sets the attenuator to 80 dB
Description:	Sets the attenuator independently of the level control, in 10 dB increments, from 0 to 110 dB. When using this command, the level control can independently adjust the input level to the step attenuator from at least -10 to +15 dBm with the PL command. This now allows the RF output level to be varied over approximately 25 dB without the step attenuator switching. It is included for compatibility with older Hewlett Packard (Agilent) instruments.	

SHRF

Syntax:	SHRF
Example:	N/A
Description:	This mode disables the automatic level control. It is included for compatibility with older Hewlett Packard (Agilent) instruments.

SHSL

Syntax:	SHSL *d* DB	
Example:	SHSL80DB	! Sets the attenuator to 80 dB
Description:	Sets the attenuator independently of the level control, in 10 dB increments, from 0 to 110 dB. When using this command, the level control can independently adjust the input level to the step attenuator from at least -10 to +15 dBm with the PL command. This now allows the RF output level to be varied over approximately 25 dB without the step attenuator switching. It is included for compatibility with older Hewlett Packard (Agilent) instruments.	

SHRL

Syntax:	SHRL
Example:	N/A
Description:	Re-couples the attenuator to the leveling control system. The step attenuator will now switch at each 10 dB boundary of the level range.

3.3.18 Instrument Control Commands

Instrument Control Commands	Model	
	124XXA	125XXA/ 127XXA
CS	√	√
DN	√	√
DU	√	√
EF	√	√
EK	√	√
IH	√	√
IP	√	√
NSR	√	√
PH2	√	√
RC	√	√
RFD	√	√
SHM4	√	√
SHS1	√	√
SV	√	√
UP	√	√
CONTRAST d	√	√
CONTRAST?	√	√

CS

Syntax:	CS
Example:	N/A
Description:	Clears the 16-bit status bytes that report the instrument status.

DN

Syntax:	DN
Example:	N/A
Description:	Decreases the value of the active parameter by its step size. If, for example, the last command sent to the instrument was CW5GZ then the CW frequency parameter will be the active parameter. If the step size for the CW frequency was 100 MHz, then sending DN will decrease the frequency by 100 MHz. Equivalent to pressing the Down Button.

DU

Syntax:	DU *n*	
Example:	DU 1	! Displays 'Remote Operation'
Description:	This command specifies what will be displayed on the instrument screen during GPIB operation. The (currently) valid values of *n* are: 0 Leaves the screen blank. 1 Displays **Remote Operation** on the screen. 2 Displays normal menus during GPIB operation. Reports any errors on the message line. 3 Displays normal menus and writes on the message line (bottom line of the screen) each GPIB command as it's received (marked *Recd:*) and after it's executed (marked *Done:*). Reports any errors on the message line. 6 Scrolls up the screen the most recent 12 GPIB commands received (marked *Recd:*) and executed (marked *Done:*). Leaves the bottom line free to report errors. 7 - Displays error messages only. These will scroll down to fill the screens, then scroll up. This mode is used to avoid slowing down the system when only errors needed to be identified. The LED below the PULSE key toggles when a GPIB command is sent to the unit.	

EF

Syntax:	EF
Example:	N/A
Description:	Disables the front panel knob to prevent inadvertent parameter changes.

EK

Syntax:	EK
Example:	N/A
Description:	Enables the front panel knob.

IH

Syntax:	IH
Example:	N/A
Description:	Clears all lists, level-correction tables and setups from non-volatile memory; writes zeros to the cleared memory locations. Reinitializes the heap-space manager.

IP

Syntax:	IP
Example:	N/A
Description:	Sets all instrument settings to factory values; sets the instrument to CW mode at the instrument's minimum frequency. Clears all lists, level-correction tables and setups from non-volatile memory and reinitializes the heap-space manager.

NSR

Syntax:	NSR
Example:	N/A
Description:	The normal operation of the remote mode displays the words **Remote Operation** on the screen. Sending NSR will cause the screen to show the same information displayed when in local mode. For example if the CW command were to be sent, the 'Fixed Frequency' menu will be displayed. The NSR command is a 'toggle'. Each time it is sent the screen display toggles from **Remote Operation** to standard menu.

PH2

Syntax:	PH2
Example:	N/A
Description:	In instruments with Option 20, this command will force the instrument control system to always keep the high power amplifier module in the circuit. Normally, the high power amplifiers are only used if the output RF power is set to +15 dBm or higher. This command is used primarily for doing the level characterization. Leaving the high power amplifiers in place at low power levels will cause accuracy errors as well as added noise.

RC

Syntax:	RC *n*	
Example:	RC 1	! Recall front panel setup #1
Description:	Recalls the selected front panel setup from non-volatile memory. There are ten memory locations, 0-9.	

RFD

Syntax:	RFD *n*	
Example:	RFD 1	! RF on during frequency change
Description:	The RF output of the instrument is normally reduced by about 40 dB during frequency changes to prevent any potential damaging overshoot (to a users equipment, not the instrument). Sending RFD1 will disable this feature and leave the RF on at all times except band and filter crossing points. Sending RFD0 re-enables the normal operation.	

SHM4

Syntax:	SHM4 *d* [HZ | KZ | MZ | GZ]	
Example:	SHM4 100MZ	! Run Self Test in 100 MHz steps
Description:	Activates Self Test and allows setting the step size to *d* [HZ | KZ | MZ | GZ], where *d* is the frequency increment (a decimal number with possible decimal point and/or exponent) and [HZ | KZ | MZ | GZ] is the units terminator. Self test will step the instrument over its entire frequency range in the selected steps. If any of the frequencies across the range causes failures, that frequency will be returned. See OD in Section 3.3.16 for a description of the output string.	

SHS

Syntax:	SHS *n*	
Example:	SHS1	! Blank the display
Description:	Sending SHS1 will completely blank the front panel display. This feature is provided for those applications requiring security. Sending SHS0 turns the display back on.	

SV

Syntax:	SV *n*	
Example:	SV 1	! Save front panel setup in #1
Description:	Saves the current front panel setup in non-volatile memory. There are ten memory locations, 0-9. All instrument parameters are saved, including modes not currently active.	

UP

Syntax:	UP
Example:	N/A
Description:	Increases the value of the active parameter by its step size. If, for example, the last command sent to the instrument was CW5GZ then the CW frequency parameter will be the active parameter. If the step size for the CW frequency was 100 MHz, then sending UP will increase the frequency by 100 MHz. Equivalent to pressing the Up Button.

CONTRAST d

Syntax:	Contrast *d*
Example:	Contrast 128
Description:	Sets the LCD Contrast to the integer value specified by *d*. 0 <= d <= 255.

CONTRAST?

Syntax:	Contrast?
Example:	Contrast?
Description:	Returns the current value of LCD Contrast.

4

Performance Verification

4.1 Introduction

Introduction (Performance Verification)	Model	
	124XXA	125XXA/ 127XXA
4.1.1 - Recommended Equipment	√	√

- This chapter provides step-by-step procedures to verify performance of the Series 12000A Microwave Synthesizers for all three models (Modulation related items are in Section 4.4 for the Series 125XXA/127XXA models)
- Sectional header page references are only provided for items pertaining directly to performance verification testing
- The required warm-up time before testing is 72 hours. The warm-up period can be reduced to 30 minutes if timebase accuracy is not to be tested for all three models
- In these procedures, the instrument being tested may be referred to as the 12000A or UUT (Unit Under Test) for all three models

4.1.1 Recommended Equipment

The following equipment is recommended before starting the performance test routines (the recommended equipment can be substituted provided the specifications are sufficiently compatible):

Table 4-1: Series 12000A Recommended Equipment

Equipment	Example
Frequency Standard	10 MHz Stanford Research FS 725
Oscilloscope	Tektronix TDS3052B or Equivalent
Microwave Frequency Counter	XL Microwave 3260 or Equivalent
Power Meter and Sensor	Giga-tronics 8541C/Series 8650A w/ 80313A Sensor or Equivalent
Spectrum Analyzer	HP 8566B or Equivalent
Detector	Herotek Model DZ262-44 or Equivalent
Function (Audio) Generator	Stanford Research DS-345 or Equivalent
Measuring Receiver	HP 8902A or Equivalent
Distortion Analyzer	HP 339A or Equivalent
L.O. Generator	Giga-tronics Microwave Synthesizer 12720A or Equivalent
Universal Counter	Racal Dana 2201 or Equivalent
Mixer IF Amplifier w/ Divide-by-40 Output	Giga-tronics Mixer/Divider (P/N 002CA04900)
Mixer (For Attenuator Test)	Marki M40020MJ
Filter 21.4 MHz	Mini-Circuits SVP 21.4
Fixed Attenuator 3 dB	Midwest ATT-0263-03-SMA-02
Fixed Attenuator 10 dB	Midwest ATT-0263-10-SMA-02

4.2 Performance Tests

Performance Tests	Model		Page
	124XXA	125XXA/ 127XXA	
4.2.1 - Introduction (Performance Tests)	√	√	4-2
4.2.2 - Frequency Range, Resolution & Accuracy	√	√	4-3
4.2.3 - Spurious Signals Tests	√	√	4-4
4.2.4 - Signal Sideband Phase Noise	√	√	4-6
4.2.5 - RF Output Power Tests	√	√	4-7

4.2.1 Introduction

The procedures in this section verify the electrical performance of the 12000A using the specifications in Chapter 1. Use Sections 4.1 through 4.3 for features that are applicable to all three models. Use Sections 4.4 through 4.5 for native specification data for the Series 125XXA/127XXA models.

Each of the performance tests includes a list of recommended test equipment. There is a consolidated list at the beginning of this chapter. Equivalent test equipment can be substituted provided that the accuracies and specifications are sufficiently compatible.

A test data sheet is included for entering the various readings taken. The specification and tolerance range is listed for ease of verification. It is suggested that copies be made of the manual sheets. When automated tests are run, a printed data sheet is produced.

Performance verification is recommended at least every two years, or more often when required to ensure proper operation of the instrument.

Each procedure specifies a required warm-up time if the procedure is to be done individually. Only one warm-up period is required for a sequence of tests. Test equipment must be warmed up according to specifications.

4.2.2 Frequency Range, Resolution & Accuracy

4.2.2.1 Description

Connect the 12000A RF output to the input of a frequency counter. The internal timebase of the counter is a reference for the 12000A to eliminate timebase errors from the measurements. This procedure does not check for timebase accuracy, and therefore the frequency in the 12000A display should agree with the counter, within the resolution of each instrument. It is possible for a fault in the 12000A to cause a frequency error even though the lock indicators show normal operation. For this reason a number of specific frequencies are tested. Test frequencies have been selected so that any defective circuits will be easily isolated.

4.2.2.2 Equipment Required

UUT • Frequency Counter • Coaxial Cable

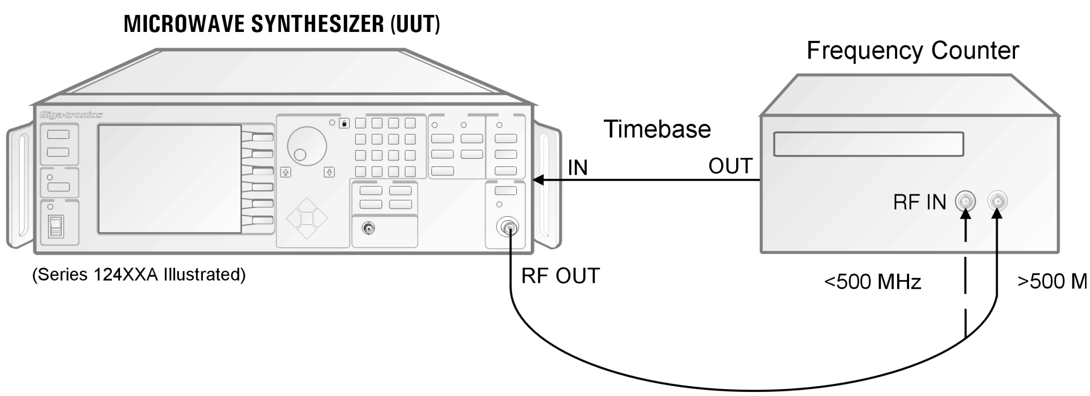

Figure 4-1: Frequency Range, Resolution & Accuracy

4.2.2.3 Procedure

1. Connect the equipment as shown in Figure 4-1. Connect the 12000A RF Output to the 10 to 500 MHz counter input using the coaxial cable and the SMA to BNC adapter. Allow the equipment to warm up for at least 30 minutes. Because the 12000A and the counter use the same timebase, timebase errors are eliminated. The 12000A will automatically switch to the external reference when it is connected.

2. Set the 12000A to 10 MHz. Press **[LEVEL]** in the POWER field and enter **[-] [1] [0] [DBM]**. Press **[RF ON]** in the RF OUTPUT field to turn on the RF output.

3. Set the 12000A to each frequency listed on the data sheet and verify that the counter reads the set frequency plus or minus the counter resolution. This tests each divider stage.

4. Connect the 12000A RF Output to the 500 MHz to 26.5 GHz input on the counter and continue with the divider tests.

5. To check that the multipliers are functioning properly, refer to the test data sheet and program each of the listed frequencies into the 12000A by entering (for example) **[CW] [2] [0] [0] [1] [MHZ]**. For each listed frequency the counter should read the entered frequency ±1 Hz, plus or minus the counter resolution. Ignore all frequencies outside the range of the instrument under test.

4.2.3 Spurious Signals Tests

4.2.3.1 Description

The output of the 12000A is connected to a spectrum analyzer. Various frequencies are selected and the analyzer tuned to determine the presence of either harmonically or non-harmonically spurious signals.

4.2.3.2 Equipment Required

UUT • Spectrum Analyzer • Coaxial Cable

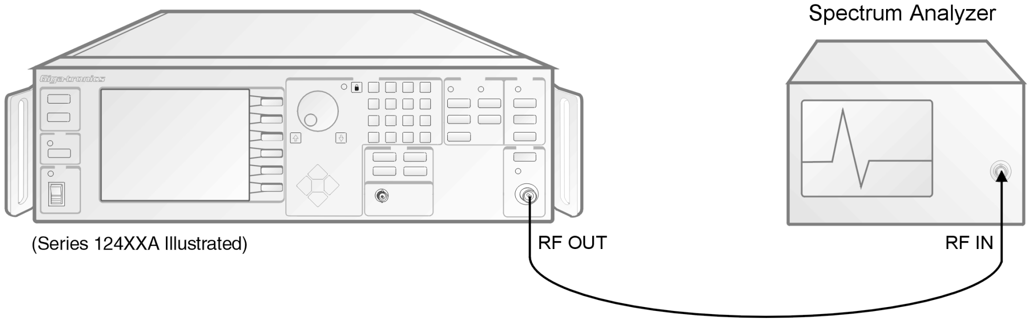

Figure 4-2: Spurious Signals Tests

4.2.3.3 Procedure

1. Connect the equipment as shown in Figure 4-2. Allow the equipment to warm up for at least 30 minutes. Press **[CW]** in the FREQUENCY field on the 12000A and enter the first test data sheet frequency within the range of the 12000A. The RF amplitude should be at +6 dBm. Press **[RF ON]** to turn on the RF output. Be certain that all modulation is OFF.

2. Set the spectrum analyzer to view the 12000A output signal. Adjust the analyzer reference level so that the peak of the displayed signal is at the top graticule line.

3. Set the spectrum analyzer to maximum span with the signal centered on the screen. Gradually narrow the span, keeping the signal centered, to observe any spurious signals. Use appropriate resolution and video bandwidths to allow sufficient dynamic range.

4. Repeat steps 2 and 3 for the other frequencies on the test data sheet which are within the operating range of the instrument.

Many spectrum analyzers have a tuned preselector when the frequency is above about 2 GHz. This reduces the likelihood of analyzer generated spurious signals, but does not eliminate the possibility. If in doubt, increase the RF attenuation of the analyzer by 10 dB. The signal in question should be reduced by exactly 10 dB. If not, it is analyzer generated. It is also important for frequencies below the range of the preselector that sufficient analyzer RF Attenuation be used (typically 30 dB) to avoid the analyzer generating harmonics of the input signal. The above attenuator shift technique will also allow verification of harmonic levels.

If a spurious signal appears to be out of specification, first check that the fundamental signal level is at +6 dBm. Next verify the analyzer accuracy by connecting a known amplitude signal (from the 12000A, for example) at the spurious frequency.

The adjusting knob on the 12000A may generate some noise spikes when it is rotated. The acquisition of the various phase lock loops in the instrument can also cause transients (within the specified settling time). Both of these effects will disappear when a steady state condition has been reached.

It is important to identify the particular class of spurious signal as the specifications may be different for each. If the spurious signal is an exact multiple of the 12000A RF output then the harmonic specification applies. Any other spurious signals must meet the non-harmonically related specification.

For frequencies above the fundamental range of the spectrum analyzer, either a mixer supplied with the spectrum analyzer or an external mixer and local oscillator may be used to downconvert the signal. Care must be taken to identify spurious signals which are inherently generated by the mixing process.

4.2.4 Single Sideband Phase Noise

4.2.4.1 Description

The test in this procedure is limited by the measuring system and verifies only the majority of the phase noise specification. To completely test the phase noise specification requires a far more sophisticated measurement system. This test uses the spectrum analyzer to make all measurements from 100 Hz to 1 MHz offsets. The 100 Hz and 1 MHz offsets are particularly susceptible to measurement system limitations.

4.2.4.2 Equipment Required

UUT • Spectrum Analyzer • Coaxial Cable

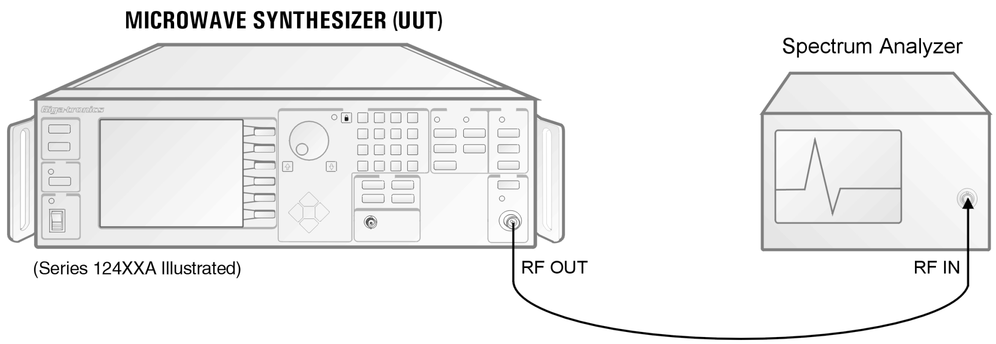

Figure 4-3: Single Sideband Phase Noise

4.2.4.3 Procedure

1. Connect the 12000A RF output to the spectrum analyzer input. Place the 12000A on a foam pad to isolate it from any external mechanical vibrations, which could affect the phase noise measurement.
2. Turn off all modulation on the 12000A.
3. For the first frequency on the test data sheet within the range of the instrument, press **[CW]** and enter the frequency. Tune the spectrum analyzer to the generator frequency and adjust the 12000A RF level to obtain a reference of 0 dBm on the analyzer. This allows direct measurement of the phase noise by the analyzer.
4. Set the analyzer span such that the desired offset is at ±2 divisions, select an appropriate bandwidth, activate the phase noise measurement and place the marker two divisions to the right of the carrier. Read the phase noise in dBc/Hz. Repeat for all offsets.
5. Repeat steps 3 and 4 for the other test data sheet frequencies which are within range of the 12000A.

4.2.5 RF Output Power Tests

4.2.5.1 Description

Although it is possible to make the following measurements manually, it is extremely tedious. It is recommended that an automated system be set up to take and record the data. Three tests are run. The first measures the maximum available output with the level control loop disabled. The second verifies the accuracy and flatness across the operating frequency range at a fixed output (0 dBm). The remaining test checks the step attenuator accuracy at a number of frequencies. This section outlines the general procedure followed by the automated system, a similar measurement could be done manually.

4.2.5.2 Equipment Required

UUT • Local Oscillator • Measuring Receiver & Sensor • Downconverter • Plotter • Computer & Programs

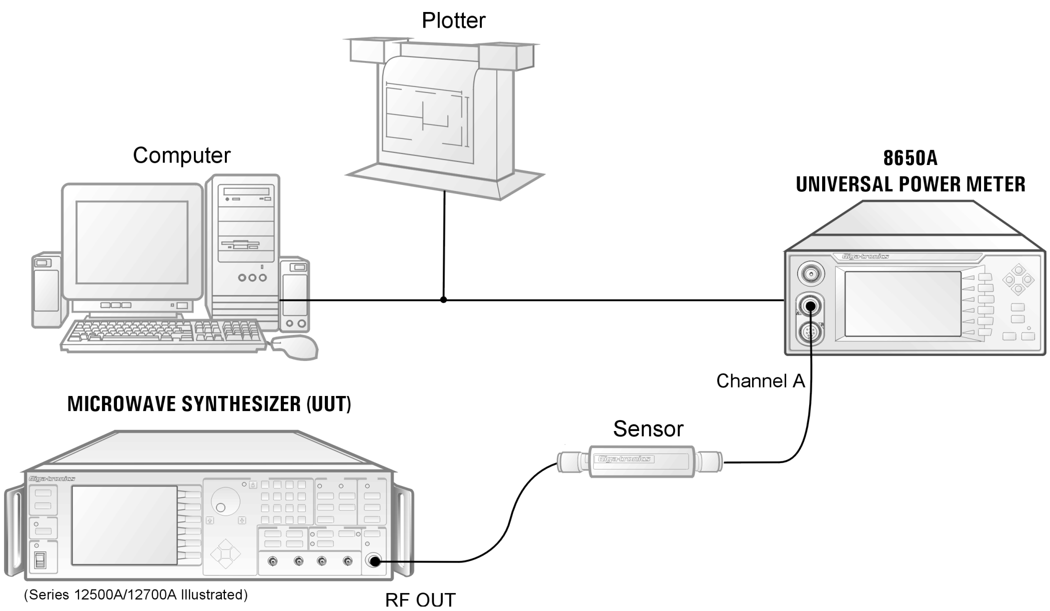

Figure 4-4: RF Output Power Test

4.2.5.3 Procedure (Output Power)

1. Connect the power sensor to the 12000A. Disable the leveling system of the 12000A. Step the frequency across the particular instrument operating range in 50 MHz increments. At each point measure the power, apply the appropriate sensor correction factor, and plot the result.
2. Using the above setup, set the 12000A to 0 dBm with the leveling enabled. Again, step the frequency across the operating range; measure, correct, and plot the power.
3. Repeat this procedure for the remaining test frequencies.

☛ ***NOTE:** When measuring the flatness and accuracy of the model 12000A, consideration must be given to the various measurement uncertainties in the test system. These include, but are not limited to, VSWR, Cal Factor uncertainty and calibration.*

4.2.5.4 **Procedure** (Attenuator Test: Option 26)

1. Connect the 12000A to the measuring receiver via the downconverter. With the 12000A at 0 dBm and set to the first test frequency; set LO 21.4 MHz above UUT set frequency. Establish a reference on the receiver in a tuned RF level mode. Reduce the 12000A output in 10 dB steps, observing and recording the receiver reading. As needed, perform the recalibration requested by the receiver.

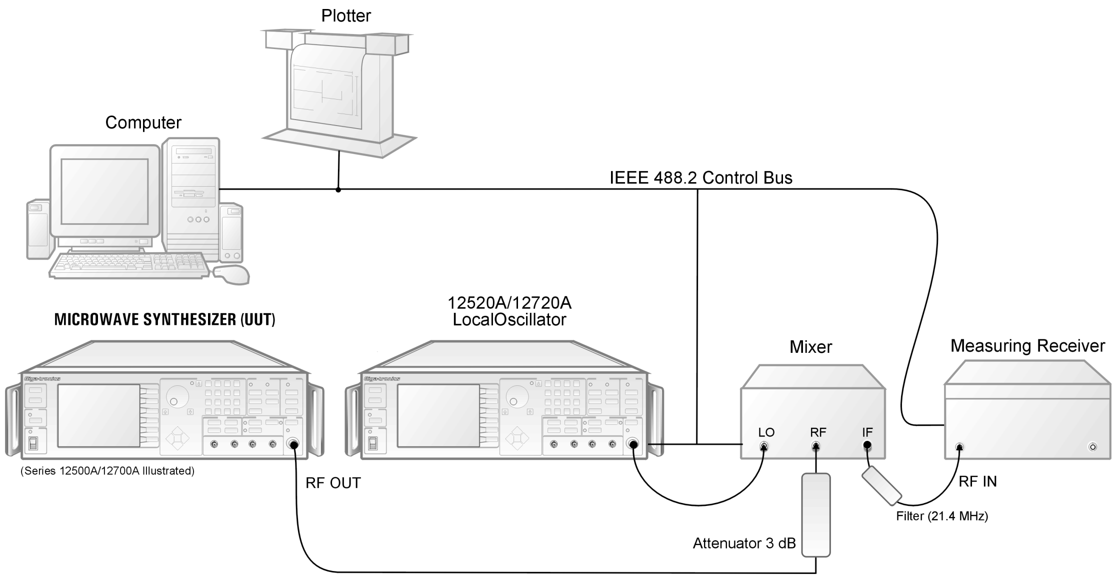

Figure 4-5: RF Output Power Attenuator Test

2. Repeat this procedure for the remaining test frequencies.

☛ ***NOTE:*** *When measuring the flatness and accuracy of the model 12000A, consideration must be given to the various measurement uncertainties in the test system. These include, but are not limited to, VSWR, Cal Factor uncertainty and calibration.*

4.3 Calibration

Calibration	Model	
	124XXA	125XXA/ 127XXA
4.3.1 - Equipment & Documentation Required	√	√ (See Also 4.3.1.2)
4.3.2 - Timebase Calibration	√	√
4.3.3 - Output Amplitude Calibration	√	√
4.3.4 - Instrument Self Adjustment During Power Up	√	√
4.3.5 - Factory Calibrations	√	√

Calibration is recommended every two years.

The Series 12000A features closed-case calibration. There are no mechanical adjustments of any kind in the instrument. All calibration is done under the control and direction of the calibration software. Calibration data is stored in non-volatile RAM. Refer to the Series 12000A Microwave Synthesizers Service Manual for detailed calibration instructions (P/N 31232). There are four functions in the instrument that require periodic calibration using external sources or measurement equipment:

- Timebase
- Output Amplitude
- Frequency Modulation (Series 125XXA/127XXA Only - See Section 4.5.1)
- Amplitude Modulation (Series 125XXA/127XXA Only - See Section 4.5.2)

Other instrument functions are adjusted either at instrument turn-on or during operation. In addition to the user-initiated and automatic calibrations, there are certain factory calibration processes. The first four sections describe in general terms how user-initiated calibration is accomplished. The actual calibration process is directed by the calibration software. The remaining sections describe the adjustments that occur at power-up or when certain modes are selected, and the factory calibration processes.

The equipment required to perform user-initiated calibration consists of (1) a known accurate 5 or 10 MHz source, (2) a Giga-tronics 8540 or 8650 Universal Power Meter with an 80313A or equivalent power sensor, (3) a 1.00 to 6.00 Vdc source (this source can be a stable power supply and a voltmeter with 1% or better accuracy). Refer to Table 4-1 for the required equipment for FM calibration.

4.3.1 Equipment & Documentation Required

4.3.1.1 All Models

- Giga-tronics 12000 Cal Software CD (P/N 32464)
- Pentium™ PC with Windows 95/98™, Equipped with National Instrument IEEE 488™ Interface (Version NI-488/NI-488.2)
- Giga-tronics 8651A or 8652A Power Meter
- Giga-tronics 80313A Sensor
- Giga-tronics Series 12000A Microwave Synthesizer
- Giga-tronics Series 12000A Microwave Synthesizer Service Manual (P/N 31232)
- Male “N” to Female “K” Adapter (Only for Synthesizer Equipped with Option 23)
- 10 MHz Frequency Standard, Accuracy better than 1E-10, 5 to 5 V $_{P-P}$ into 100 ohms (Stanford Research FS 725 or Equivalent)

4.3.1.2 Additional Requirements (Series 125XXA/127XXA Only)

- DC Voltage Source 0-10 VDC, .5% Accuracy, 100 mA (Tektronix™ PS280 or Equivalent)
- Audio Oscillator, 10 Hz-200 kHz, 2 V $_{P-P}$ +/- .01 V into 50 ohm (Stanford Research™ DS-345 or equivalent)
- HP™ 8902A Measuring Receiver
- Giga-tronics Series 12520A or 12720A Synthesizer
- Giga-tronics Mixer/Divider (P/N 002CA04900)
- Digital Voltmeter 3 ½ digits (Fluke™ 8920A or Equivalent)

4.3.2 Timebase Calibration

The Series 12000A uses an internal 10 MHz oven oscillator to provide a frequency reference for the synthesizer and other associated circuits. The oscillator uses Electronic Frequency Control for its adjustment. Before calibrating the frequency of the oscillator, the instrument must be left connected to a power source for at least 24 hours. The oscillator runs when the instrument is in standby mode, so it is not necessary to have the instrument turned on during the warm-up period.

To perform the calibration, connect the 5 MHz or 10 MHz source to the Reference Input and initiate the calibration process from the service menu. The computer will determine the frequency of the external source then lock the internal oscillator to that source. After a stable phase lock has been achieved, the EFC voltage for the oscillator will be measured and stored. When the external source is removed the computer will set the EFC voltage to the stored value to maintain the set point.

4.3.3 Output Amplitude Calibration

There are three types of calibration associated with the amplitude control system. The first determines the relationship between the actual output power and the detector output voltage. Data is taken for each of the internal detectors and at each of the various gain settings in the input amplifier. The data is stored as coefficients to an equation, which describes the detector characteristic. The second set of data determine the relationship of the modulator input voltage to the change in output power. As with the detectors, data is developed for a set of coefficients used in a defining equation. The last calibration produces a table of correction coefficients as the frequency is varied over the operating range of the instrument

4.3.3.1 Power vs. Detector Voltage

For this calibration, the power sensor is connected from the power meter to the 12000A RF output, and the power meter IEEE 488 control is connected to an IEEE equipped computer. The test program supplied by Giga-tronics is now run. For each of the installed internal detectors (one is used for .01 to 2 GHz and another for 2 to 20 GHz) and for each gain range of the ALC input amplifier, the instrument will step the power and determine the relationship between the actual RF power and the dc input to the Analog-to-Digital Converter. This calibration is done at one frequency. The data taken develops a set of coefficients which are used in an equation that defines the shape of the detector curve.

4.3.3.2 Modulator Control vs. Applied Voltage

This calibration is essentially the converse of the previous one. Here the intent is to determine the relationship of the control voltage for the leveling modulator to the change in RF output power. A separate set of coefficients is developed for each octave.

4.3.3.3 Amplitude vs. Frequency Correction Factors

The last phase of the Amplitude Calibration sequence determines correction factors as the instrument is varied across its operating range. These correction factors compensate for RF path losses within the instrument and following the leveling detector. They also compensate for variations in the leveling coupler. During this test the instrument is set at a fixed amplitude and the frequency is stepped from the low to the high limit of the instrument.

4.3.4 Instrument Self Adjustment During Power Up

The following calibration adjustments are made each time the instrument is turned on:

4.3.4.1 YIG Oscillator Coarse Tuning Adjustment

Each time that the instrument is turned on an internal routine determines the setting of the YIG oscillator tuning DAC. The frequency is first set to 4.5 GHz and the DAC adjusted until the loop locks and the PLL voltage is approximately zero volts. This process is repeated at 7.5 GHz. Once the DAC settings for these two points are known, all other set points may be mathematically determined. This process insures that the coarse tuning for the oscillator is always optimized. It also allows replacement of the oscillator with no need to manually set up the tracking.

During CW and Step Sweep instrument operation the PLL control voltage is monitored by an ADC. If the voltage exceeds a narrow window around zero volts, the instrument computer automatically adjusts the coarse tune DAC in 1-bit steps to maintain the loop voltage within the window. This process occurs slowly and does not affect the instrument output. Use of this technique eliminates the possibility of unlock due to temperature variations or other drift causing mechanisms.

4.3.4.2 Tracking Filter Linearity

The tracking filter used in the synthesizer uses a wide range VCO whose tuning sensitivity varies considerably across its range. To maintain constant loop bandwidth, the loop gain is adjusted automatically as the frequency is varied.

4.3.4.3 ALC Offset

Another adjustment made each time the instrument is turned on compensates for any offset or zeroing errors in the amplifiers used for conditioning the detector outputs. Switching in the detector circuits removes the RF input of each of the detectors. An offset voltage is then summed into the input amplifier stage and the magnitude adjusted until the ADC output is near zero. This process is repeated for each gain range and each detector. The values are stored for use during leveling operation. These measurements are also taken at appropriate times during instrument operation to maintain the accuracy of the offset adjustment.

4.3.5 Factory Calibrations

4.3.5.1 ALC Temperature Compensation

To maintain accurate leveling operation over the specified temperature range, the instrument uses a set of data tables that are generated during normal instrument test. These data tables are a multi-dimensional array at various temperatures, levels, and detectors. There are sensors located adjacent to each detector to determine the temperature used by the computer for compensation purposes.

4.4 Performance Tests (Series 12500A/12700A)

Performance Tests (Series 12500A/12700A)	Model		Page
	124XXA	125XXA/ 127XXA	
4.4.1 - Amplitude Modulation Test	N/A	√	4-14
4.4.2 - Frequency Modulation Test	N/A	√	4-16
4.4.3 - Pulse Modulation On/Off Ratio Test	N/A	√	4-19
4.4.4 - Pulse Modulation Rise & Fall Time Test	N/A	√	4-20
4.4.5 - Pulse Modulation Overshoot & Settling Time	N/A	√	4-21
4.4.6 - Pulse Modulation Accuracy Test	N/A	√	4-22

Use the Performance Verification Test Data Sheet provided at the end to record your data. The data sheet is compatible with all three models.

☛ ***NOTE:*** *Units that have Option 24 will have these tests repeated using the internal generators.*

4.4.1 Amplitude Modulation Test

4.4.1.1 Description

The output from the 12000A is connected to a discriminator. The discriminator output is monitored on an oscilloscope to determine deviation and bandwidth.

4.4.1.2 Equipment Required

UUT • Mixer/Divider • Oscillator • Measuring Receiver

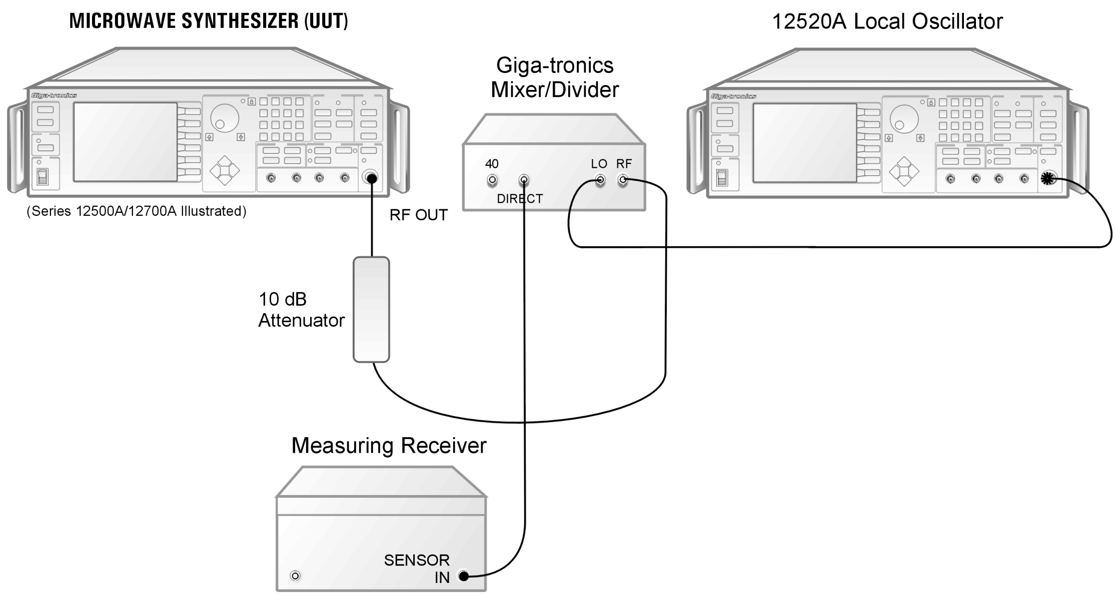

Figure 4-6: Amplitude Modulation Test

4.4.1.3 Procedure (AM Depth)

1. Set UUT to 1.5 GHz with level set at 0 dBm. Connect UUT output to the Mixer Box RF input connector with a 10 dB pad.

2. Connect LO (Source) output to the Mixer Box LO input connector. Set LO frequency to 130 MHz higher than UUT and set source leveled output to 10 dBm.

3. Connect Direct output of Mixer Box to the HP 8902 Measuring Receiver RF input.

4. Connect Modulation Output/Audio Input to channel 2 of Oscilloscope.
    a. Set to 500 mV per Division.

5. On Measuring Receiver press **[FREQUENCY]** and verify 130 MHz on receiver.

6. Select AM, set measuring receiver filters to 50 Hz and 15 KHz. Press **[(PEAK-PEAK)/2 MODE]**.

7. On UUT turn AM on. Set depth to 50%. Connect the DS-345 Function Generator at 1 KHz modulation to the AM input. Set scope to 50 Ohm termination and sinewave amplitude for a

2 V $_{P-P}$ signal. Press **[AM]** button on Measuring Receiver. Verify a reading of 40.0 to 60.0% on the measuring receiver.

8. Set external function to SQR. Turn off all filters on the measuring receiver. Verify a receiver reading of 40.0 to 60.0% (Typical).

9. Set external function to TRI and verify that the measuring receiver reads 40.0 to 60.0%

10. Set UUT to 10 GHz. Repeat Steps 2 to 8.

11. At 1.5 and 10 GHz, check AM Depth at 30, 90% modulation. Verify accuracy of +/- 10% of reading at each step.

12. Enter data in the **AM Modulation Test - AM Depth** area of the Series 12000A Microwave Synthesizers Performance Verification Data Sheet, Section 4.4.1.3.

4.4.1.4 Procedure (AM Bandwidth)

1. Set UUT to 1.5 GHz with level set at 0 dBm. Set AM Depth to 50% @ 1 KHz rate (Sinewave).

2. Verify a 50% reading on HP 8902 with filters turned off. On receiver, press **[RATIO]**, then the **[LOG/LIN]** button, display indicates 0.00 dB.

3. Vary the frequency of the external DS-345 Function Generator from DC to 150 KHz. Verify that the amount of change is within the +/- 3 dB window.

4. Repeat steps 1 to 3 for 10 GHz.

5. Complete the **AM Modulation Test - AM Bandwidth** area of the Series 12000A Microwave Synthesizers Performance Verification Data Sheet, Section 4.4.1.4.

4.4.2 Frequency Modulation Test

4.4.2.1 Description

The output from the 12000A is connected to a discriminator. The discriminator output is monitored on an oscilloscope to determine deviation and bandwidth.

4.4.2.2 Equipment Required

UUT • Function Generator • Oscilloscope • Digital Voltmeter • FM Test Fixture

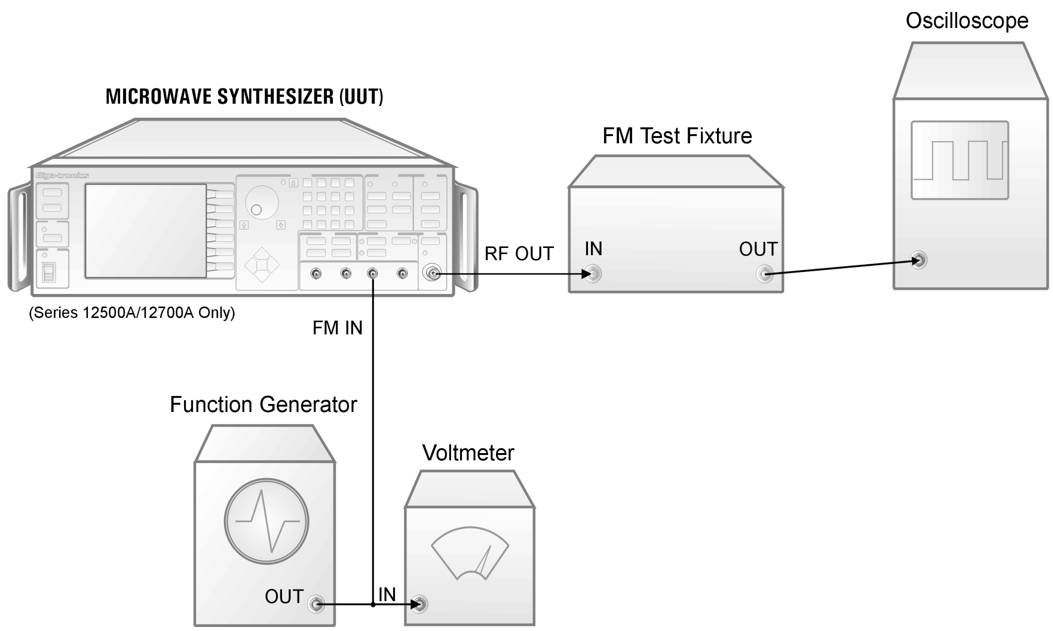

Figure 4-7: Frequency Modulation Test

4.4.2.3 Delay Discriminator Description

In order to calibrate and test the frequency modulation circuits, a special test fixture must be assembled. The recommended FM test fixture includes an RF splitter, two lines of unequal length, and an RF mixer. The RF output of the 12000A is divided by the splitter into two signals, unequally delayed.

Different length cables determine the number of frequency nulls or 0 volt outputs found in the frequency band of interest. For the Frequency Modulation performance test, the frequency band of interest is 4 to 8 GHz.

The procedure does not identify a specific mixer for the discriminator circuit. There are two factors to consider when selecting a mixer.

1. The mixer RF and LO frequency range must be greater than 4 to 8 GHz.
2. A low conversion loss mixer will provide a higher output.

Maximizing Delay Discriminator Output

Obtaining a six division change on a 5 mV scale may be difficult to obtain for a 1 MHz change in frequency. Increasing output power will improve the output of the discriminator. The output of the UUT can be adjusted to levels as high as +13 dBm or higher for the 4 to 8 GHz frequency band. The output performance of discriminator is improved with a very high cable length ratio. Cable length ratios of 16 to 1 (48 inches to 3 inches) will produce a large number of frequency nulls within the 4 to 8 GHz frequency band.

☛ ***NOTE:*** *Increasing the number of frequency nulls increases the rate of change of the output voltage per unit frequency as the output transitions through the frequency null.*

Optimal Test Performance Null Selection

The maximum deviation of the Frequency Modulation test is ±10 MHz. The rate of change for the output voltage per unit frequency ($\Delta V/\Delta F$) must remain constant (linear) for the ±10 MHz deviation range. Rate changes within this deviation range will result in a non-symmetrical waveform and will produce invalid test results.

Identifying an optimal frequency null is achieved by sweeping the frequency through the frequency range of the test and observing the Delay Discriminator waveform on an oscilloscope.

Recommended Test Equipment (FM)

- Delay Discriminator
- Digital Oscilloscope
- Pulse Generator with 1 shot Capability
- BNC Cables and Tee

Recommended Configuration

1. Connect the input of the delay discriminator to the RF output of the 12000A and the output to the digital scope.
2. Set the 12000A to Sweep Mode with the following settings:
   a. Start Frequency: 4 GHz
   b. Stop Frequency: 8 GHz
   c. Sweep Type: Ramp
   d. Sweep Time: 900 msec
   e. Repeat Mode: Single Sweep
   f. Trigger Type: Trigger in BNC
   g. Power: +10 dBm
3. Connect the output of the pulse generator to the External Trigger Input or second channel of the digital scope and the Trigger In of the 12000A.
4. Set the trigger selection of the digital scope to the port where the trigger signal will be detected (Use the BNC Tee at this port).

5. Adjust the time base of the digital scope to 1 second for the entire span of the X axis (100 mSec typical). Set the vertical scale to 100 mV per division.

6. Pulse the generator to initiate the RF sweep.

Repeat the sweep several times. The output of the Delay Discriminator should not vary from one sweep to another. Review the waveform and identify the nulls where the voltage transitions through the nulls are steeper and linear for a ±50 mV range above and below the null. Perform the FM modulation tests at these frequency nulls.

For certain frequencies, which may be identified by experiment, the mixer will produce a DC voltage near zero. The number of null frequencies can be increased by making the delay lines longer in absolute terms or by increasing the ratio between their lengths. If the output becomes frequency modulated, the mixer output voltage will change, and the voltage variation will be proportional to FM deviation.

The polarity of the voltage change may be either directly or inversely related to the direction of frequency deviation. When voltage levels have been established for different frequencies, the mixer output can be monitored on an oscilloscope to provide a continuous display of FM deviation.

4.4.2.4 Procedure

1. Connect the FM test fixture to the RF OUT connector of the 12000A as shown in Figure 4-7. Monitor the mixer output with the oscilloscope (5 mV/div). Set the 12000A to any null frequency between 4.0 and 7.99 GHz (that is, at a frequency where the mixer output voltage is zero); +10 dBm out, no modulation.

2. Establish the voltage at 1 MHz above and 1 MHz below the null frequency. Adjust the oscilloscope gain and the 12000A output power level (near +5 dBm) to place the null point at the center of the screen and the 1 MHz deviation points at 3 divisions above and 3 divisions below the null point.

3. Set the 12000A to Narrow EXT FM with 1 MHz deviation. Connect the function generator, set to a 100 kHz rate SINE wave, 2 V_{P-P}. Verify that the waveform is 6 divisions peak-to-peak.

4. Adjust the 12000A FM deviation for exactly a six division peak-to-peak display. Vary the function generator from 10 Hz to 1 MHz and verify that the display remains between five and seven divisions peak-to-peak.

5. Vary the function generator from 1 MHz to 8 MHz and verify that the display remains between 4 and 8 divisions.

6. Establish the voltage at 10 MHz above and below the null frequency. Adjust the oscilloscope gain and the 12000A output power level (near +5 dBm) to place the null point at the center of the screen and the 10 MHz deviation points at 3 divisions above and 3 divisions below the null point (terminate the Mixer output in 50 Ω).

7. Set the 12000A to Wide EXT FM with 10 MHz deviation. Set the function generator to 100 kHz. Verify that the waveform is 6 divisions peak-to-peak.

8. Adjust the 12000A FM deviation for exactly a 6-division peak-to-peak display. Vary the function generator from 100 Hz to 1 MHz and verify that the display remains between 4.7 and 7.3 divisions.

9. Vary the function generator from 1 MHz to 8 MHz and verify that the display remains between 4 and 8 divisions.

4.4.3 Pulse Modulation On/Off Ratio Test

4.4.3.1 Description

The 12000A is set to a CW frequency at a power level of 0 dBm. A spectrum analyzer is used to view the signal. The pulse modulation is then enabled and the resulting waveform is measured.

4.4.3.2 Equipment Required

UUT • Spectrum Analyzer • Pulse Generator • Coaxial Cable

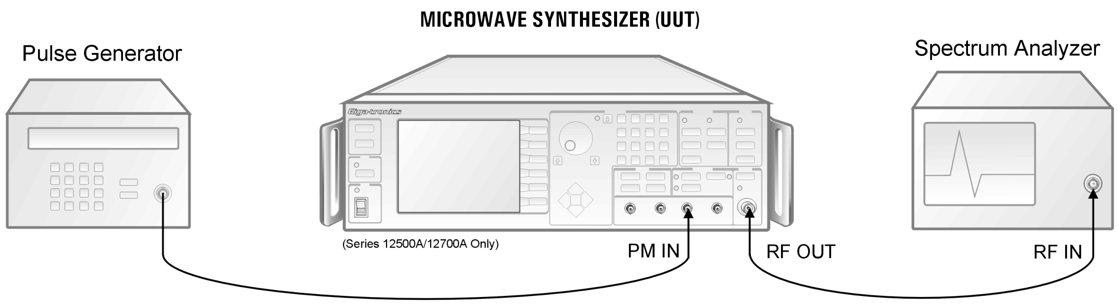

Figure 4-8: Pulse Modulation On/Off Ratio Test

4.4.3.3 Procedure

1. Connect the equipment as shown in Figure 4-8. Allow 30 minutes warm-up time.
2. Enter the first frequency on the test data sheet within the frequency range of the instrument. The RF power level should be at 0 dBm. Select external pulse modulation (PM) on the 12000A.
3. Tune the analyzer to the source frequency, select an analyzer span of 0 Hz and fine tune the analyzer to place the line at the top of the screen graticule (adjust analyzer reference level as needed).
4. Set the pulse generator for a 100 Hz square wave; press **[PULSE]** then use the softkey to turn on the pulse modulation.
5. Adjust the analyzer sweep time to display a few cycles of the waveform. Use internal triggering. Reduce resolution bandwidth and carefully retune the analyzer center frequency until the maximum resolution is achieved. Read and record the peak-to-peak value (use marker delta).
6. Repeat steps 3, 4 and 5 for all other test data sheet frequencies which are within the range of the instrument. Note that the dynamic range of the analyzer may limit its measurement capability.

4.4.4 Pulse Modulation Rise & Fall Time Test

4.4.4.1 Description

A crystal detector is connected to the 12000A, terminated in 50 Ω, and monitored with an oscilloscope.

☛ ***NOTE:*** *It is very important to use either the specified detector or one with similar rise time characteristics. Even when terminated in 50 Ω with a short cable, the detector parameters can markedly influence the measurement.*

4.4.4.2 Equipment Required

UUT • Oscillator • Pulse Generator • Crystal Detector • Coaxial Cable

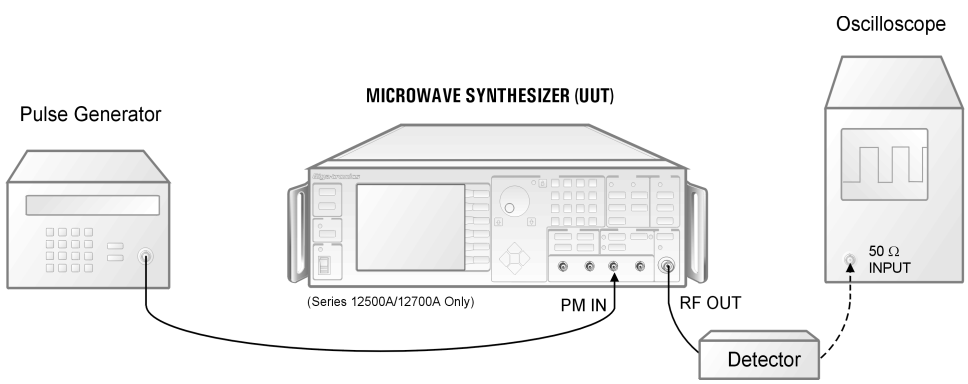

Figure 4-9: Pulse Modulation Rise/Fall Time Test

4.4.4.3 Procedure

1. Connect the equipment as shown in Figure 4-9. The cable from the detector to the oscilloscope should be kept as short as possible.
2. Press **[PRESET]** on the 12000A and set the frequency to the first test data sheet frequency within the operating range of the instrument.
3. Enable external pulse modulation (at a 1 MHz rate and 0.5 μs width) on the 12000A. Press **[PULSE]** and use the softkey to turn on pulse modulation.
4. Set the oscilloscope to 5 mV/div and using the RF Level control of the 12000A, adjust the peak to peak oscilloscope display to fall on the dotted lines on the screen (100% and 0%). Adjust the oscilloscope sweep time to 5 ns/div. Measure and record the rise and fall times between the 10% and 90% points.
5. Repeat Step 4 for each of the test data sheet frequencies within the operating range of the instrument.

4.4.5 Pulse Modulation Overshoot & Settling Time

4.4.5.1 Description

A crystal detector is connected to the 12000A, terminated in 50 Ω and monitored with an oscilloscope.

☛ ***NOTE:*** *It is very important to use either the specified detector or one with similar rise time characteristics. Even when terminated in 50 Ω with a short cable, the detector parameters can markedly influence the measurement.*

4.4.5.2 Equipment Required

UUT • Oscillator • Pulse Generator • Crystal Detector • Coaxial Cable

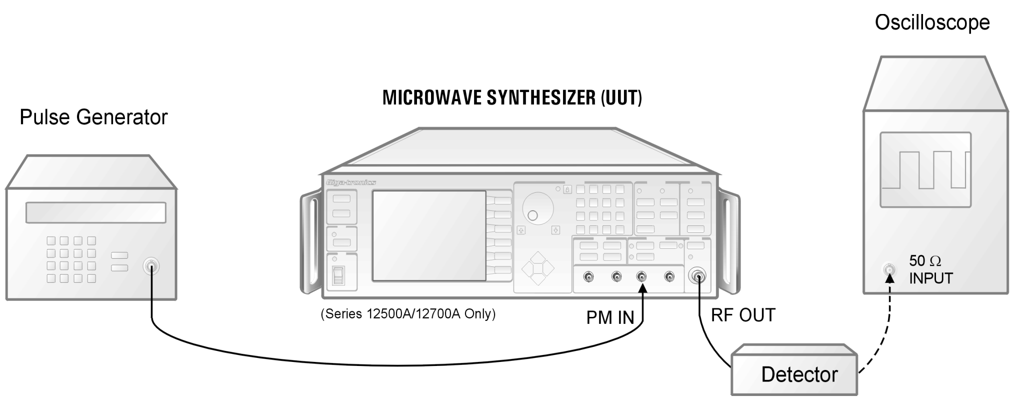

Figure 4-10: PM Overshoot and Setting Time

4.4.5.3 Procedure

1. Connect the equipment as shown in Figure 4-10. The cable from the detector to the oscilloscope should be kept as short as possible.
2. Press **[PRESET]** on the 12000A and set the frequency to the first test data sheet frequency within the operating range of the instrument.
3. Enable external pulse modulation (at a 1 MHz rate and 0.5 ms width) on the 12000A. Press **[PULSE]** and use the softkey to turn on pulse modulation.
4. Set the oscilloscope to 5 mv/div and using the RF Level control of the 12000A and the vertical position of the oscilloscope, adjust the peak to peak oscilloscope display to be from the top of the screen (pulse off) to 2 divisions below the center line (pulse on). Adjust the oscilloscope sweep time to 50 ns/div. Change the level setting of the 12000A by plus and minus 1 dB and note the graticule position of the pulse on level. Return to the original value. Measure and record the time for the pulse to be within 1 dB of its final value.
5. Change the level setting of the 12000A by plus and minus 2 dB and note the graticule position of the pulse on level. Return to the original level. Measure and record any undershoot/overshoot of the signal.
6. Repeat Steps 4 and 5 for each of the test data sheet frequencies within the operating range of the instrument.

4.4.6 Pulse Modulation Accuracy Test

4.4.6.1 Description

In this test the peak pulse level is compared to the level in the CW mode.

4.4.6.2 Equipment Required

UUT • Oscilloscope • Pulse Generator • Crystal Detector • Coaxial Cable

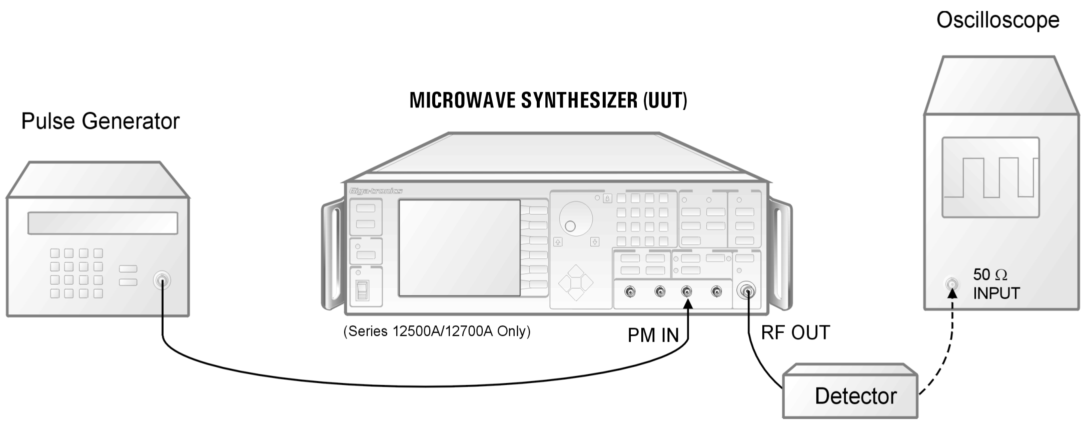

Figure 4-11: Pulse Modulation Accuracy Test

4.4.6.3 Procedure

1. Connect the equipment as shown in Figure 4-11. The oscilloscope input impedance should be 50 Ω. Allow 30 minutes warm-up.

2. Press **[PRESET]** on the 12000A and set the frequency to the first test data sheet frequency within the operating range of the instrument.

3. Set the oscilloscope to 5 mv/div and using the vertical position of the oscilloscope, adjust the trace to the centerline of the screen. Change the level setting of the 12000A by plus and minus 1 dB and note the trace position on the screen. Return to 0 dBm.

4. Enable external pulse modulation (at a 200 kHz rate and 0.1 µs width) on the 12000A. Press **[PULSE]** and use the softkey to turn on pulse modulation.

5. Measure and record the difference between the CW reference level and the negative peak of the pulse.

6. Change the pulse width to 50 ns and again measure and record the difference between the CW reference level and the negative peak of the pulse.

7. Repeat Steps 3-6 for each test data sheet frequency within the operating range of the instrument.

4.5 Calibration (Series 12500A/12700A Native)

Calibration (Series 12500A/12700A)	Model	
	124XXA	125XXA/ 127XXA
4.5.1 - Frequency Modulation Calibration	N/A	√
4.5.2 - Amplitude Modulation Calibration	N/A	√
4.5.3 - Mode Related Calibrations	N/A	√

Use Section 4.3 for calibration data pertaining to all three models. Use this section for native specific data belonging to the 125XXA/127XXA models. Refer to the Series 12000A Microwave Synthesizers Service Manual for detailed calibration instructions (P/N 31232).

4.5.1 Frequency Modulation Calibration

The calibration of the Frequency Modulation function is accomplished by using a known external source (the 1 Vdc supply) to measure various gains within the FM system. For this test, it is recommended that the external power source be connected to the FM input with a series resistor of approximately 500 Ω. This will provide about a 10:1 voltage divider (the FM input is 50 Ω). Measure the voltage at the input connector with a digital voltmeter and set it to 1.00 V. For those parts of the test requiring a zero volt input, simply remove the connection to the FM input connector and the internal 50 Ω pull-down resistor will establish zero volts.

The FM calibration is divided into two parts, the low band and the high band. In the low band, the DDS portion may be directly calibrated since the DDS provides a fixed frequency increment for every accumulator set point bit increment. This allows calculating the multiplication coefficient for converting FM-ADC bits to DDS bits. Once the DDS is calibrated, it provides a precise shift in the loop control voltage. This voltage is null'ed using an internal voltage previously calibrated by the 1 Vdc source. The gains and offsets required to produce the null become the calibration factors for the high band.

4.5.2 Amplitude Modulation Calibration

The calibration of the Amplitude Modulation function is accomplished by using a known external source (the 1 V and 6 V supply) to measure various gains within the AM system. For this test, it is recommended that the external power source be connected to the AM input with a series resistor of approximately 600 Ω for 1 volt and 600 Ω for 6 volts. This will provide about a 10:1 or 2:1 voltage divider (the AM input is 600 Ω). Measure the voltage at the input connector with a digital voltmeter and set it to 1.00 V or 6.00 V as prompted. For those parts of the test requiring a zero volt input, simply remove the connection to the AM input connector and the internal 600 Ω pull-down resistor will establish zero volts.

Since the Amplitude Modulation system is dc coupled, the application of the accurate 1 Vdc source allows the instrument computer to set the gain calibration to produce an appropriate shift in carrier power. Once this calibration has been done, application of a modulating signal will produce the proper depth.

4.5.3 Mode Related Calibrations

Whenever this mode of operations is selected (as always, through the AM Menu) and the AM function is turned on, the instrument automatically performs a calibration of the modulator at whatever output frequency has been selected. Whenever either the frequency, power level, or both are to be changed, the preferred procedure is to switch the AM function off, make whatever frequency and/or power level changes are desired, then switch AM function back on. This technique provides the best possible accuracy for SCAN over its 60 dB range.

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Performance Verification Test Data Sheet (Page 1 of 2)

Under Test Result record measured values (if any). In the case of a function check or range check, write OK to indicate that the unit under test meets specifications.

Serial Number:		Tested By:	
Date:		Quality Assurance:	

Frequency Range, Resolution, Accuracy		
	Frequency	**Harmonics**
4.2.2.3	12 MHz	
	24 MHz	
	48 MHz	
	100 MHz	
	200 MHz	
	400 MHz	
	750 MHz	
	1500 MHz	
	3 GHz	
	6 GHz	
	12 GHz	
	18 GHz	

Spurious Signals Tests			
	Frequency (MHz)	**Harmonics**	**Non-Harmonics**
4.2.3.3	770.550		
	1513.425		
	4004.000		
	9182.433		
	17361.522		

Single Sideband Phase Noise (dBc/Hz)						
	Frequency (MHz)	**Offset from Carrier**				
		100 Hz	1 kHz	10 kHz	100 kHz	1 MHz
4.2.4.3	1513.425					
	4004.000					
	9182.433					
	17361.522					
	23541.349					

RF Output Power			
	Test Result		
4.2.5.3	Max. Power Level		
	Power Level		
4.2.5.4	Step Attenuator Test Frequencies	1.0 GHz	
		4.0 GHz	
		12.0 GHz	
		17.0 GHz	

SERIES 12000A MICROWAVE SYNTHESIZERS

Performance Verification Test Data Sheet (Page 2 of 2)

Serial Number:		Tested By:	
Date:		Quality Assurance:	

Amplitude Modulation Test (SERIES 12500A/12700A ONLY)							
AM Depth (+/- 10%)		**30%**		**50%**		**90%**	
4.4.1.3	**Frequency 1.5 GHz**	Int.	Ext.	Int.	Ext.	Int.	Ext.
	Sinewave						
	Square Wave						
	Triangle Wave						
	Frequency 10 GHz	Int.	Ext.	Int.	Ext.	Int.	Ext.
	Sinewave						
	Square Wave						
	Triangle Wave						
AM Bandwidth (Spec. +/- 3 dB)		**Int.**			**Ext.**		
4.4.1.4	Frequency 1.5 GHz						
	Frequency 10 GHz						

Frequency Modulation Test (SERIES 12500A/12700A ONLY)					
Parameter		**@1 GHz**	**@4 GHz**	**@12 GHz**	**@20 GHz**
4.4.2.3	Deviation (5.7 - 6.3 div)				
	Bandwidth (5 - 7 div)				
	Bandwidth (4 - 8 div)				
	Deviation (5.7 - 6.3 div)				
	Bandwidth (5 - 7 div)				
	Bandwidth (4 - 8 div)				

Pulse Modulation Test (SERIES 12500A/12700A ONLY)					
Frequency (GHz)		**1.0**	**4.0**	**12.0**	**20**
4.4.3	On/Off				
4.4.4	Rise/Fall				
4.4.5	Overshoot/Settling				
4.4.6	Accuracy				

A

Accessories & Options

A.1 Introduction

Introduction (Accessories & Options)	Model	
	124XXA	125XXA/ 127XXA
	√	√

The following accessories and options are available for the Series 12000A Microwave Synthesizers. Each accessory and option is described under its respective heading in this appendix.

Table A-1: Accessories & Options

Accessory/ Option No.	Description	Part Number	Field Installable
A001	Cable Kit (SMA)	29847	N/A
A002	Rack Mount with Slides	29901	Yes
A003	Rack Mount without Slides	29902	Yes
A010	Extra Operation Manual	31231	N/A
	Series 12000A Service Manual	31232	N/A
A011	Ruggedized Carrying Case	29855	N/A
20	High Power RF Output **(SEE SECTION 1.5.3 FOR OPTION LIMITATIONS THAT APPLY TO ONLY THE SERIES 124XXA MODEL)**	29884	Yes*
22	Rear Panel RF Out	29888	Yes*
23	Type N RF Output Connector	29891	Yes*
24	Internal Modulation Generator **(SERIES 125XXA/127XXA ONLY)**	29890	Yes*
26	Step Attenuator (20 GHz Instruments)	29882	Yes*
29	Scan Modulation **(SERIES 125XXA/127XXA ONLY)**	29913	No
30	International Configuration	29892	No
36	1 kHz Frequency Resolution	29892	N/A
	Labview Driver	29886	N/A

* = At Service Center

A.2 Accessories

Accessories	Model	
	124XXA	125XXA/ 127XXA
A.2.1 - A001: Cable Kit (SMA)	√	√
A.2.2 - A002: Rack Mount with Slides	√	√
A.2.3 - A003: Rack Mount without Slides	√	√
A.2.4 - A010: Operation Manual	√	√
A.2.5 - A011: Ruggedized Carrying Case	√	√

A.2.1 A001: Cable Kit (SMA)

This accessory kit furnishes two coaxial cables (18 and 72-inches) with connectors for interfacing to user-supplied signal sources.

A.2.2 A002: Rack Mount with Slides

This is a field kit for mounting the Series 12000A in a standard equipment rack. The kit includes mounting slides. The kit is available from Giga-tronics with part number 29901. The components included are listed below.

A.2.3 A003: Rack Mount without Slides

This is a field kit for mounting the Series 12000A in a standard equipment rack. The kit does not include mounting slides. The kit is available from Giga-tronics with part number 29902.

A.2.4 A010: Operation Manual

Use part number 31231 to order additional copies of the instrument's Operation manual. Use part number 31232 to order the Series 12000A Microwave Synthesizers Service Manual.

A.2.5 A011: Ruggedized Carrying Case

This is a special ruggedized carrying case for transporting the instrument between work sites. It can be ordered from Giga-tronics with part number 29855.

A.3 Options

Options	Model	
	124XXA	125XXA/ 127XXA
A.3.1 - Option 20: High Power RF Out	√ (Limitations Apply, See Section 1.5.3)	√
A.3.2 - Option 22: Rear Panel RF Output Connector	√	√
A.3.3 - Option 23: Type N RF Output Connector	√	√
A.3.4 - Option 24: Internal Modulation Generator	N/A	√
A.3.5 - Option 26: Step Attenuator (20 GHz Instruments)	√	√
A.3.6 - Option 29: Scan Modulation	N/A	√
A.3.7 - Option 36: 1 kHz Frequency Resolution	√	√

A.3.1 Option 20: High Power RF Out

Option 20 provides the instrument maximum power specification changed to +20 dBm if installed. This change is accomplished by adding a pair of amplifiers and a coaxial relay. The coaxial relay is used to either bypass the amplifiers (for set points below +11 dBm) or place them in the circuit when the power requested is +11 dBm or higher. The operation of the relay is automatic, based on the requested power unless high power is disabled. The ALC menu has an entry for high power that allows either Automatic operation or disable mode. The table below lists the specifications that are changed when Option 20 is active. Specifications apply from 0^{o} to 35^{o}C.

☛ ***NOTE:*** *Due to the losses in the relay and the extra cables, the maximum power of the instrument with Option 20 disabled is 2 dB less than the standard instrument specification.*

A.3.2 Option 22: Rear Panel RF Output Connector

Option 22 provides the RF output connector which is relocated to the Series 12000A's rear panel if installed. Option 22 can be installed with or without Option 26.

A.3.3 Option 23: Type N RF Output Connector

Option 23 changes the RF output connector to Type N if installed.

A.3.4 Option 24: Internal Modulation Generator

Option 24 provides two built-in function generators for creating AM, FM and pulse envelopes only for the Series 125XXA/127XXA models. This option has been incorporated into the main body of the publication; a procedure or specification applies only to instruments with this option where a note to that effect is included.

A.3.5 Option 26: Step Attenuator (20 GHz Instruments)

Option 26 provides an attenuator which is placed in the RF output path of the instrument, providing up to 110 dB of attenuation in 10 dB increments. This option has been incorporated into the main body of the publication; a procedure or specification applies only to instruments with this option where a note to that effect is included.

A.3.6 Option 29: Scan Modulation

Option 29 provides Scan Modulation only for the Series 125XXA/127XXA models.

A.3.7 Option 36: 1 kHz Frequency Resolution

Option 36 provides a frequency resolution to the instrument of 1 kHz if installed.

B

Firmware Field Upgrade

B.1 Introduction

Introduction (Firmware Field Upgrade)	Model	
	124XXA	125XXA/ 127XXA
	√	√

This following describes the process by which the Series 12000A Microwave Synthesizers may have its application firmware upgraded using a straight-through RS-232 cable. The following components are necessary:

- A PC running Windows 95, 98, 2000, or NT 4.0 with a free serial COM port
- A DB9 male-to-female, straight-through RS-232 cable
- A checksummed binary file of the desired synthesizer firmware and the download utility for Giga-tronics products both of which can be obtained after Download Registration at the Giga-tronics website, **www.gigatronics.com**

B.2 Series 12000A Firmware Upgrade Procedure

Series 12000A Firmware Upgrade Procedure	Model	
	124XXA	125XXA/ 127XXA
	√	√

Series 12000A firmware code is in the form of V07X-BXX-XX, where V07X can be either V072 or V073. Verify the version firmware currently installed by turning on the 12000A and observing the version firmware number on the start-up screen. If your code is V073, then proceed to download the latest version firmware following the instructions on the Giga-tronics website (after Download Registration).

If the instrument firmware version is V072, contact the factory to obtain instructions on the upgrade procedure for the unit.

☛ ***NOTE:*** *If the latest version firmware is installed in a V072 instrument without the proper procedure, the upgrade will not finalize.*

For information on the upgrade procedure for version V072 instruments please contact Giga-tronics at 800.726.4442 or 925.328.4650 or E-mail us at info@gigatronics.com.

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Series 12000A Microwave Synthesizers

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